*A star (✱) indicates that the Abstract deals with Apparatus and Instruments.*

## FEBRUARY, 1937.

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# GENERAL PHYSICS.

## ADSORPTION.

**406. Interaction of Atoms and Molecules with Solid Surfaces. Parts VI and VII. J. E. Lennard-Jones and A. F. Devonshire. Part VIII. A. F. Devonshire.** *Roy. Soc., Proc.* 158*A*. *pp.* 242–279, *Jan.* 15, 1937.—In Part VI the energy levels of adsorbed He atoms for motion perpendicular to a surface of a LiF crystal, deduced in a previous paper [see Abstract 3379 (1936)] from the diffraction experiments of Frisch and Stern, are used to construct a map of the potential field between gas atom and solid. Calculations are then made of the lateral velocity of migration of He atoms in this field. Whereas according to classical mechanics He atoms would remain vibrating about a mean position at very low temperatures, according to quantum mechanics the atoms can migrate along the surface, however low the temperature. There is an apparent increase of mass of about 8 % but otherwise the atoms move as though the lateral potential barriers did not exist. In Part VII a theory of the diffraction of atoms at surfaces is worked out and explicit formulæ are given for the intensities of diffracted beams. It is shown how a comparison of theory and experiment may be made in order that the constants of surface fields may be determined. The inverse process, whereby atoms running along a surface are diffracted so as to be evaporated, is examined and a specific formula evaluated for the average time which elapses before the phenomenon occurs. The free path of an atom evaporated by this mechanism appears in a particular case to be of the order of $10^{-5}$ cm. It is shown that equilibrium between a gas and an adsorbed film can be established by the diffraction mechanism and that the condition for equilibrium is expressed by a Langmuir adsorption isotherm. In Part VIII a formula for the thermal accommodation coefficient of a monatomic gas on a solid is obtained for the case when there is an attractive field between the gas and the solid. The theory is applied to the case of He and Ne on W. Satisfactory agreement with experiment is obtained, and an estimate is made of the values of the constants of the potential field. AUTHORS.

**407. Heat of Adsorption of Gas by Charcoal at Low Temperatures. R. Lepointe.** *J. de Physique et le Radium*, 7. *pp.* 469–472, *Nov.*, 1936.—The heat evolved is measured by a calorimeter at constant temperature of − 180° (liquid oxygen). The heat evolved is greater at the outset of the adsorption than during adsorption. $H_2$ shows an exceptionally great thermal evolution at the beginning which leads to the assumption that a superficial stable combination is formed between $H_2$ and C. This appears to be confirmed by the rôle played by $O_2$ in the purification of the wood charcoal used. J. K.

**408. Polymolecular Adsorbed Films. Part II. Condensation of Vapours on Finely Divided Solids. R. S. Bradley.** *Chem. Soc., J. pp.* 1799–1804, *Dec.*, 1936.—The equation $\log (p_s/p) = K_1K_3^a + K_4$, where $p$ and $p_s$ are the pressure and saturation pressure respectively, $a$ is the weight adsorbed, and $K_1$, $K_3$, and $K_4$ are constants, has been deduced for the adsorption of dipolar vapours on finely divided solids. Agreement is obtained with published experimental data over a wide range of $p/p_0$, except at high pressures, when capillary condensation occurs. The formation of liquid meniscuses is discussed. [For Part I see Abstract 5320 (1936).] AUTHOR.

**409. Adsorption by Dehydrated Chabasite. A. B. Lamb and J. C. Woodhouse.** *Am. Chem. Soc., J.* 58. *pp.* 2637–2646, *Dec.*, 1936.—Chabasite shows a maximum adsorption of $H_2$, $O_2$ and $CO_2$ at 0°, when 97·8, 96·9 and 92·9 %, respectively, of its original water has been removed at suitable temperatures. It shows a similar maximum adsorption of $CO_2$ at the same percentage dehydration at temperatures of 34·5, 61·2 and 100°. This behaviour is explained as due to the collapse of the crystal skeleton when the last fractions of the water are removed. Slightly dehydrated chabasite exhibits a pronounced specificity of adsorption toward $H_2$, $O_2$ and $CO_2$. This behaviour is explained on the assumption of several limiting pore sizes and of differing extents of the corresponding inner surfaces. AUTHORS.

**410. Adsorption on Gels. Part I. K. S. Rao and B. S. Rao.** *Indian Acad. Sci., Proc.* 4*A*. *pp.* 562–570, *Nov.*, 1936.—The effect of temperature of activation on the capillary space in alumina and ferric oxide gels is studied. Structural changes in alumina gel are noticed near 500° C. and 900° C. and their significance is discussed. Adsorption on alumina and ferric oxide gels from binary mixtures of liquids is studied and the behaviour of these is compared with that of silica. It is concluded that the chemical nature of a gel markedly affects selective adsorption from binary mixtures of liquids. AUTHORS.

**411. Potential Difference at an Air-Water Interface. J. A. Chalmers and F. Pasquill.** *Phil. Mag.* 23. *pp.* 88–96, *Jan.*, 1937.—Experiments described show a value of 0·26 volts for the sum of the p.d.'s water-air, air-wet filter paper, and filter paper-water. Subsidiary experiments are described, and it is suggested that this is a manifestation of the p.d. at the water-air boundary, probably due to a double layer consisting of orientated water molecules at the surface. AUTHORS.

*See also* Abstracts 534, 536, 950.

## ATOMIC AND MOLECULAR STRUCTURE.

**412. Geometric Theory of Matter. G. Fournier.** *Comptes Rendus*, 203. *pp.* 1138–1140, *Nov.* 30, 1936.—Hypothesising that as far as their fields are concerned the elementary particles in a nucleus may be regarded as completely filling space, a study has been made of the shape of the volume occupied by each particle. It is decided that a combination of octahedra and tetrahedra is, excepting a simple cubical system, the only possibility. The octahedra have 4 times the volume of the tetrahedra and are accordingly chosen for the α-particles, the tetrahedra being assigned to particles of unit mass, *e.g.*, protons and neutrons. The energy of the particle is represented by the distance of the centre of its polyhedron from the general centre of the morula and it is found that various nuclear properties can then be deduced. Conditions for stability are given and the existence of nuclear isomers is predicted. The number of lines in the α-ray spectra of radioactive bodies is calculated and agrees well with experiment. J. E. R. C.

**413. Structure of Nuclei Between Helium and Oxygen. E. Feenberg and E. Wigner.** *Phys. Rev.* 51. *pp.* 95–106, *Jan.* 15, 1937.—

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In order to test the present assumptions on nuclear forces, the theory is applied to the nuclei in which the first *p* shell of protons and neutrons is being built up, *i.e.*, to the nuclei with masses between 5 and 16. The Hartree-Fock approximation is used for the numerical calculations, but the more qualitative results are independent to a large degree of the approximations used. The angular momenta of the ground states appear to be given correctly by the theory. Although the wave functions used do not correspond to preformed $\alpha$-particles, the first-order energies exhibit a marked four-shell structure. The experimental energy difference between the nuclear pairs (N, N + 1), (N + 1, N) may possibly be somewhat larger than the difference in the electrostatic energies. Support for the use of spin exchange (Heisenberg) forces to account for the singlet-triplet separation in the deuteron is found in the singlet-triplet separation inferred from the $Li^6 - He^6$ normal state energy difference. However, the $B^{10} - Be^{10}$ and $N^{14} - C^{14}$ normal state differences do not fit the simple theory which is adequate for the singlet-triplet spacing in the two and six particle problems. AUTHORS.

**414. Symmetry of the Nuclear Hamiltonian and the Spectroscopy of Nuclei. E. Wigner.** *Phys. Rev.* 51. *pp.* 106–119, *Jan.* 15, 1937.—The structure of the multiples of nuclear terms is investigated, using as first approximation a Hamiltonian which does not involve the ordinary spin and corresponds to equal forces between all nuclear constituents, protons and neutrons. The multiplets turn out to have a rather complicated structure, instead of the S of atomic spectroscopy, one has three quantum numbers, S, T, Y. The second approximation can either introduce spin forces (method 2), or else can discriminate between protons and neutrons (method 3). The last approximation discriminates between protons and neutrons in method 2 and takes the spin forces into account in method 3. The method 2 is worked out schematically and is shown to explain qualitatively the table of stable nuclei to about Mo. AUTHOR.

**415. Artificial Radioactivities and Search for the Negative Proton. R. J. Walen and M. E. Nahmias.** *Comptes Rendus*, 203. *pp.* 1149–1151, *Nov.* 30, 1936.—The possibility of obtaining the negative proton by the reactions $^{11}_{5}B + ^{1}_{0}n \rightarrow ^{11}_{6}C + ^{\;1}_{-1}\pi$, or $^{26}_{12}Mg + ^{1}_{0}n \rightarrow ^{26}_{13}Al + ^{\;1}_{-1}\pi$ was examined without result. An improved method of detecting radioactive products of short period applied to the bombardment of Be [see Abstract 3919 (1936)] confirmed the period of the product as 0·8 ± 0·4 sec.; it is half absorbed by 0·16 gm./cm$^2$ Pb. B similarly examined showed an activity about 2 % that of Be with a period of about 1 sec., probably due to $^{11}_{5}B + ^{1}_{0}n \rightarrow ^{8}_{3}Li + ^{4}_{2}He$; the period of 0·02 sec. is ascribed to $^{12}_{5}B$. Li similarly re-examined showed an activity about 2·5 % that of Be with a period 0·75 ± 0·05 sec., thought to be due to $^{8}_{3}Li$ formed by neutron capture. The results of Knol and Veldkamp [see Abstract 1399 (1936)] are considered to be probably due to irregular working of the counter. C. A. S.

**416. Radioactivity Induced in Sulphur. R. Sagane.** *Phys. Rev.* 50. *pp.* 1141–1145, *Dec.* 15, 1936.—Under bombardment of 4–6 eMV deuterons, S becomes radioactive with the emission of both positive and negative electrons with 3 periods 3 ± 0·1 *m*, 33 ± 1 *m*, and 14 ± 0·3 *d*. The decay periods are found to have their origin in $P^{30}$, $Cl^{34}$ (both positron emitters) and $P^{32}$ (negative electron emitter). The energy distribution of positrons from Cl is studied by a cloud chamber. When bombarded by neutrons two radioactive substances are produced which emit negative electrons. The half-value periods are found to be 2·6 ± 0·2 *h* and 14 *d*, which are characteristic of $Si^{31}$ and $P^{32}$. AUTHOR.

**417. α-Particle Bombardment of Ne, Ca and A and Masses of Light Nuclei. E. Pollard and C. J. Brasefield.** *Phys. Rev.* **51.** *pp.* 8–11, *Jan.* 1, 1937.—Under bombardment by ThC′ α-particles Ne and Ca have been found to emit protons while A does not. The maxmum energies of the protons have been measured: the nuclear energy changes are for the Ne reaction $-\,2{\cdot}6_4$ eMV and for calcium $-\,4{\cdot}2_3$ eMV. In each case only one group was found. Using Aston's recent value for the mass of $Ne^{20}$ we deduce that the mass of $Na^{23}$ is 22·9972. Data from a number of transmutations are used together with mass spectrographic values to give a table of isotopic masses from $Ne^{20}$ and $A^{40}$ with four exceptions. AUTHORS.

**418. D–D Nuclear Reaction. R. Döpel.** *Ann. d. Physik,* **28.** 1. *pp.* 87–96, *Jan.,* 1937.—An apparatus is described by means of which deuterons can be bombarded by high velocity deuterons. In the apparatus the accelerating electrode is charged negatively with respect to earth, and the observations are taken in the interior of a cage which is insulated and maintained at a high potential. This arrangement is designed to give a maximum efficiency from the high potential system. Two nuclear processes take place which are :—${}_1D^2 + {}_1D^2 = {}_1H^1 + {}_1H^3$, and ${}_1D^2 + {}_1D^2 = {}_2He^3 + {}_0n^1$. The output of neutrons and protons from these reactions was determined between 10 and 200 kV. It is found to lie at about $10^{-9}$ at 100 kV. which is about three times lower than previous determinations. It was found possible to observe both reactions down to the lower limits of the apparatus, *i.e.,* 5–8 kV. A comparison is made with the results of other workers. G. O. B.

**419. Intermediate Nucleus and Atomic Disintegration in Steps. W. D. Harkins.** *Phys. Rev.* **51.** *pp.* 52–53, *Jan.* 1, 1937.—The theory that disintegration of an atomic nucleus by an impinging neutron is preceded by capture of the neutron and formation of an intermediate nucleus [see Abstracts 2478 and 3390 (1936)] is amplified. The life period of such a nucleus is independent of its component provided it is in a definite excited state; it depends on its excited state and the energy thereof, and on the nature and energy states of its possible products; it should decrease as the energy of the impinging neutron increases. The products of disintegration depend on the energy and angular momentum of the intermediate nucleus. The process may occur in several steps, and may result in re-formation of the original components. C. A. S.

**420. Disintegration of Beryllium by γ-Rays. V. I. Mamasachlisow.** *Phys. Zeits. d. Sowjetunion,* **10.** 2. *pp.* 214–218, 1936. *In German.*—In the nucleus ${}_4Be^9$ the last neutron is very loosely bound, and its average distance from the rest of the nucleus will, because of its zero-point energy, be much larger than the radius of the residual nucleus. Therefore the neutron may be described as moving in a field of force of very small extension. Then the knowledge of the binding energy is sufficient to fix the wave function and hence the cross-section for the photoelectric effect. The difference from the corresponding calculation for the deuteron consists in the fact that in the Be nucleus the neutron has an orbital angular momentum of one unit. The calculated values of the cross-section are compared with approximate experimental figures. R. P.

**421. Nuclear Photoelectric Effect in Beryllium. L. I. Rusinov and A. N. Sagaidak.** *Phys. Zeits. d. Sowjetunion,* 10. 2. *pp.* 203–213, 1936. *In German.*—$\gamma$-rays of Rn produce photo-neutrons in Be. These are slowed down by paraffin spheres of varying thickness and are then observed with the aid of the radioactivity they induce in Rn, Ag, Mn and I. The effect is compared with that of neutrons produced in Be by $\gamma$-rays from Rn. After allowing for the different mean free path of the two types of neutrons in paraffin due to their different velocity, the number of photo-neutrons appears to be 0·54 of the neutrons produced in Be by the $\alpha$-rays of the same source. In a second experiment the total activity induced in the Mn atoms of an aqueous solution of $KMnO_4$ is found. This yields a value of 0·35 for the number of photo-neutrons in terms of the number of neutrons produced by $\alpha$-rays. If the difference between the two results is due to the fact that the $\alpha$-particles from Rn produce many very slow neutrons, the second figure should be more reliable. The result is compared with other experiments and with theory. R. P.

**422. Separation of Lithium Isotopes. G. N. Lewis and R. T. Macdonald.** *Am. Chem. Soc., J.* 58. *pp.* 2519–2524, *Dec.,* 1936.—From the ordinary mixture of Li isotopes, $Li^6$ is enriched in an 18-m. column, where fine drops of Li amalgam fall through a solution of LiCl in absolute ethyl alcohol or of LiBr in a mixture of alcohol and dioxane. At the bottom of the column, the Li is extracted from the amalgam and added as Li salt to the ascending electrolytic solution. After the passage of 10 l. of amalgam through the solution, the material at the bottom of the column is removed for the analysis, which consists in determining the atomic weight of this Li, relative to that of ordinary Li. This is accomplished by the exact titration of dry $Li_2CO_3$ against a solution of HCl. In the final experiment, the isotopic ratio $Li^7$ to $Li^6$ is changed from 11·6 in ordinary Li to 5·1 in our material. The results show that, under equivalent conditions, the electrode potential between amalgam and alcohol solution is greater for $Li^7$ than for $Li^6$ by at least 0·0006 volt. AUTHORS.

**423. Deuterium Abundance Ratio in Cholesterol. M. Dole and R. B. Gibney.** *Am. Chem. Soc., J.* 58. *pp.* 2552–2555, *Dec.,* 1936.—Cholesterol is examined for its D content, but after all the necessary corrections are applied to the data it appears that the D content is normal. The measurements indicate a slight deficiency of D, but the magnitude of the deficiency is hardly greater than the experimental error. Halibut liver oil residues have also been analysed isotopically, but again the hydrogen appears to be normal in its D content. It is found, however that there is a marked fractionation of the O isotopes on combustion of the cholesterol. AUTHORS.

**424. Passage of Fast Neutrons Through Beryllium. L. I. Rusinov.** *Phys. Zeits. d. Sowjetunion,* 10. 2. *pp.* 219–222, 1936. *In English.*—The activity induced in a Ag target by fast neutrons is found to increase when the neutrons pass through Be. Experiments are described which point to the disintegration of Be by neutrons as causing this effect. The effective cross-section for this reaction must be of the order of $10^{-25}$ cm$^2$. AUTHOR.

**425. Neutron-Proton Interaction. W. D. Harkins, M. D. Kamen, H. W. Newson and D. M. Gans.** *Phys. Rev.* 50. *pp.* 980–991, *Dec.* 1, 1936.—An experimental investigation of the angular distribution of protons produced by the bombardment of H nuclei with fast neutrons is made using a Wilson cloud chamber and two cameras to give a stereoscopic projection of the proton tracks, of which some 700 were observed. $H_2$, $C_2H_4$ and $H_2S$ were employed as gaseous media. The curve of intensity plotted against angle of scattering shows a maximum in the region of 25°, while the distribution referred to unit solid angle shows a continuous rise with decreasing angle. Various distorting factors, both geometrical and statistical, are described and their effects allowed for. The results agree with little of the previous work. Modern nuclear theories are shown to be inadequate to explain the results. Some interaction of the exchange type is apparently necessary at energies lower than those theoretically predicted for a satisfactory explanation. Agreement is obtained with Fermi's explanation for the efficiency of H nuclei in slowing fast neutrons. G. O. B.

**426. Scattering of Neutrons in Matter. Part IV. L. S. Ornstein.** *K. Akad. Amsterdam., Proc.* 39. 10. *pp.* 1166–1170, 1936.—By statistical methods, the problem of the mean free paths of neutrons impinging on an infinite layer of matter is considered. Expressions are obtained for the mean free paths for neutrons which have suffered one, two or *n* collisions. The law of the distribution of the neutrons in space as well as the distribution of their velocities in magnitude and direction, is also discussed. [For Parts II and III see Abstract 18 (1937).] G. O. B.

**427. Magnetic Scattering of Slow Neutrons. L. J. Laslett.** *Phys. Rev.* 51. *pp.* 22–24, *Jan.* 1, 1937.—To determine whether the large cross-sections for the scattering of slow neutrons by Fe and Ni arise in part from the ferromagnetic nature of these materials, a comparison of the scattering at room-temperature and above the Curie point was made. As no significant change in scattering was found, the conclusion is drawn that the largeness of these cross-sections is not of magnetic origin. It is pointed out, however, that this result does not preclude the neutron possessing a magnetic moment of the order of magnitude of a nuclear magneton. AUTHOR.

**428. Magnetic Properties of the Neutron. J. R. Dunning, P. N. Powers and H. G. Beyer.** *Phys. Rev.* 51. *p.* 51, *Jan.* 1, 1937.—To determine any effect in the way of alignment or polarisation of neutrons due to their magnetic moment on passing through strongly magnetised material the scattering of a beam of neutrons was examined after passing through two sheets of iron magnetised to saturation (*a*) both normal to the beam, (*b*) one normal, the other at 70°, and (*c*) both at 65°. It was found that reversal of the magnetisation of the first plate had no effect with *a* and *b*, and $\ngtr 2\%$ with *c*, which is barely in excess of the experimental error. Neutrons were then passed through a similar magnetised plate ("polariser") at 45° or 30°, and then scattered from the pole face of a separate magnet (analyser). Comparison of results with the fields of analyser and polariser parallel and anti-parallel showed a slight but consistent difference, which though scarcely more than the experimental error, is thought perhaps to indicate a slight effect by reason of its consistency. C. A. S.

**429. Maximum Valency of Elements and Atomic Structure. B. Ormont.** *Acta Physicochimica*, 5. 4. *pp.* 593–603, 1936.—In extension of previous work [see Abstract 2481 (1936)] a short introductory discussion is given of possible different types of interaction between the components within the "sphere of coordination" of a complex compound and the possible effects (both energetic and steric) upon the chemical reactivity

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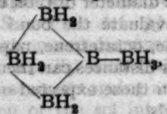
of the molecules involved. Mention is made of some preliminary experimental results upon the reaction of Br with allyl alcohol in the form of the di- and tri-alcoholate of $MgCl_2$. The di-alcoholate shows little reaction but one alcohol molecule of the tri-alcoholate is brominated briskly. L. A. W.

**430. Theory of Metallic Bond. Part III. P. Gombás.** *Zeits. f. Physik*, 104. 1–2. *pp.* 81–92, 1936.—The expression derived in an earlier publication [see Abstract 2954 (1936)] for the lattice energy of metals is further investigated, and it is shown that for the alkali metals a useful approximation is obtained when only those terms are considered, which contribute to the reciprocal effect of the metallic electrons with the ions. Based on this reduced formula for the lattice energy, simple relationships are obtained which in the cases of the alkali metals indicate that the lattice energy is inversely proportional to the lattice constant, while the compressibilities are proportional to the fourth power of the lattice constant. Both relationships were confirmed by experimental data. The calculations of the lattice constant and of the sublimation energy of K by means of the above simplified formula for the lattice energy, also lead to results which are in excellent agreement with experiment. No arbitrary constants of any kind are introduced. H. H. Ho.

**431. Nature of the Hydrate Bond for Ions of Transition Elements. G. Joos.** *Ann. d. Physik*, 28. 1. *pp.* 54–58, *Jan.*, 1937.—Former views [see Abstract 956 (1927)] that the carriers of colour and magnetism in the case of the transition elements may be the non-polar united complexes whose electron sheaths have no longer any connection with those of the free ions, are now criticised, corrected and amplified in the light of the new quantum mechanics and the experimental methods. It is shown that only among the Co alums, does a single case occur in which by hydrate formation a reconstruction of the electronic sheath takes place in the sense of creating a real stable complex structure. This complex is, however, far less stable than the homologous $NH_3$ complex. In the cases of all the other ions of the Fe group, the water bond is conditioned, mainly by electrostatic forces, whereby the field effect remains restricted to the suppression of the orbital moment which is always observed. H. H. Ho.

**432. Electronic Affinity of the Hydroxyl Group. J. Goubeau.** *Zeits. f. phys. Chem.* 34. *Abt.B.* 6. *pp.* 432–442, 1936.—The lattice energy is calculated from known data of the lattice structure of LiOH to be 205 k.cal./mol. By means of this value, the electronic affinity of the OH group is given as 76 k.cal./mol. by two independent cyclic processes. The electronic affinity so evaluated is a composite figure for atomic groups, and enables the calculation of the lattice energies of the other alkali hydroxides to be made viz.:—NaOH, 176; KOH, 153; RbOH, 147; and CsOH, 136 k.cal./mol. Also the hydration energies of $\overline{OH}$ and $\overset{+}{H}$ are 88 and 260 k.cal./mol. respectively. H. H. Ho.

**433. Structure of Pentaborane. S. H. Bauer and L. Pauling.** *Am. Chem. Soc., J.* 58. *pp.* 2403–2407, *Dec.*, 1936.—From the study of electron diffraction photographs of $B_5H_9$ it is concluded that the substance has the structure , the fifth B atom being coplanar with the square four-membered ring. The values found for interatomic distances are B–B = 1·76 ± 0·02Å. and B–H = 1·17 ± 0·04Å. AUTHORS.

**434. Molecular Structures of the 2-Butenes and the 2,3-Epoxybutanes. L. O. Brockway and P. C. Cross.** *Am. Chem. Soc., J.* 58. *pp.* 2407–2409, *Dec.*, 1936.—The direct determination of the molecular structures by electron diffraction of the vapours has led to the following identification of the isomeric forms and molecular sizes of *cis* and *trans* 2-butene and *cis* and *trans*-2,3-epoxybutane:

| | | B. p., °C. | Mm. | C–C, Å. | C=C, Å. |
|---|---|---|---|---|---|
| 2-Butene | *Cis* | 3·0 | 746 | 1·54 ± 0·03 | 1·38 ± 0·03 |
| | *Trans* | 0·3 | 744 | 1·56 ± ·04 | 1·40 ± ·04 |
| | | | | | C—O, Å. |
| 2,3-Epoxy-butane | *Cis* | 54 | 747 | 1·54 ± ·03 | 1·43 ± ·03 |
| | *Trans* | 60 | 747 | 1·54 ± ·03 | 1·43 ± ·03 |

AUTHORS.

**435. Electronic Structure of Polyenes and Aromatic Molecules. Part I. J. E. Lennard-Jones. Part II. J. E. Lennard-Jones and J. Turkevich. Part III. W. G. Penney.** *Roy. Soc., Proc.* 158*A*. *pp.* 280–324, *Jan.* 15, 1937.—In Part I a general method is developed for calculating the lengths of links and the energies of conjugated organic molecules by means of molecular orbitals. General formulæ are given for the lengths of the links in conjugated hydrocarbon chains, and it is shown that in short chains there are two kinds of links, one rather longer than a true double link and the other intermediate between a true single and a true double link. In long chains both links tend to become equal to 1·38Å. In Part II general formulæ are given for the lengths of links of cyclic aromatic molecules. Benzene is shown to be a regular hexagon of length 1·37Å, whereas other cyclic molecules are found to be irregular and to consist of alternately long and short links. Calculations have been made of the energies of these molecules and the effect of "resonance" is estimated. The method has also been applied to diphenyl and naphthalene. Part III: The most satisfactory way of interpreting the conclusions of the electron-pair theory of "resonance" is to say that linkages involving resonance are of fractional order. A convention is suggested by which the exact order of linkages may be calculated. The essential feature is that it gives a direct relation between the bond order and the bond energy. Thus, for example, the bond order in benzene is 1·623, and the excess of this figure over 1·5 measures the effect of the resonance. Once the bond order has been determined, the bond energy may be estimated by interpolating between single- and double-bond energies. The heats of formation of hydrocarbons with resonance may in this way be found as easily as those of ordinary molecules. Similar interpolation may be made for other properties, such as internuclear distance, which are closely connected with bond energy. From the known internuclear distances in compounds containing C, the dependence of the ionic diameter of C on the bond order may be found. Using the theory to evaluate the bond orders in the conjugated systems butadiene, hexatriene, octatetrene, naphthalene, and the infinite chain, the various internuclear distances can then be predicted. The results are appreciably different from those expected on the classical idea of alternating single and double bonds. AUTHORS.

**436. Modification of Rast's Micro-Method for Molecular Weight Determination. Yun-Pu Liu and Tsung-Pi Chou.** *Chinese Chem. Soc., J.* 4. *pp.* 422–428, *Nov.*, 1936. *In English.*—Further modifications on the modified Rast's micro-method for molecular weight determination are made by choosing a melting-point bulb in place of the melting-point tube. The molecular weights of 20 different substances are determined, these in general having a smaller percentage deviation than those determined by previous authors. AUTHORS.

***437. Atomic Weights of C, N and F by Microbalance Method. W. Cawood and H. S. Patterson.** *Roy. Soc., Phil. Trans.* 236*A*. *pp.* 77–102, *Nov.* 24, 1936.—Following theoretical considerations, comes a description of experiments leading to improvement in the accuracy of the micro-balance method for the determination of atomic weights. A quartz micro-balance of the torsion type was used, in which the beam was suspended by two tightly stretched quartz fibres at right angles to the motion of the beam; errors and difficulties are fully discussed, and full experimental details are given. The preparations of the following pure gases are described. $O_2$, $CO_2$, $C_2H_4$, $N_2O$, $SO_2$, $CF_4$ and $CH_3F$. The following atomic weights are determined: N, 14·007; C, 12·01; F, 18·996, all on the chemical scale of O = 16·000. H. H. Ho.

**438. Relative Atomic Weight of Oxygen in Water and in Air. Part II. M. Dole.** *J. Chem. Phys.* 4. *pp.* 778–780, *Dec.*, 1936.—Purified Lake Michigan water appears to be nearly exactly intermediate in density between purified Atlantic Ocean water and water condensed from the atmosphere. Within the experimental error the entire difference in density between fresh and salt water appears to be due to differences in the oxygen isotopic ratios. The bearing of these results on theories explaining the relatively large concentration of $O^{18}$ in the atmosphere is discussed. [For Part I see Abstract 1923 (1936).] AUTHOR.

**439. Atomic Weight of Aluminium. J. I. Hoffman and G. E. F. Lundell.** *Bureau of Standards, J. of Research,* 18. *pp.* 1–18, *Jan.*, 1937.—In this redetermination of the atomic weight of Al, weighed portions of the metal were converted to the hydroxide and sulphate, respectively. These were then heated until they were changed to the oxide, $Al_2O_3$, which was finally ignited at 1,200 to 1,300° C. By this procedure, the atomic weight is related directly to that of oxygen. Careful analyses showed that the metal contained only very small quantities of impurities and disclosed no gases in the highly ignited oxide. Proper corrections were made for the small amount of impurities in the metal, and special precautions were taken to prevent absorption of moisture by the ignited oxide during weighing. The value for the atomic weight based on this work is $26 \cdot 974 \pm 0 \cdot 002$. AUTHORS.

*See also* Abstracts 478, 491, 530, 603, 604, 624, 642, 676, 678, 683, 689, 693, 700, 707, 742, 846, 885, 886, 906.

## COLLOIDS.

**440. Dialysis in the Study of Colloids. Part IV. Colloidal Arsenious Sulphide. C. B. Joshi, P. M. Barve, and B. N. Desai.** *Indian Acad. Sci., Proc.* 4*A*. *pp.* 590–602, *Nov.*, 1936.—Tables of measurements are given and discussed for the variation of cataphoretic speed, stability, and viscosity with dialysis and dilution, and for cataphoretic speed measurements on ageing and on exposure to sunlight. Changes in the composition of the sol introduce considerable complications, hence no general conclusions bearing on the theory of coagulation of colloids can be deduced. The results given in the four papers of the series support the physical point of view, based on the adsorption of the ions of the peptising electrolytes by the colloidal particles, and not the chemical point of view of the origin of charge. [For Part III see Abstract 22 (1937).] N. M. B.

**441. Spontaneous Stable Formation of Colloids. J. W. McBain and M. E. L. McBain.** *Am. Chem. Soc., J.* 58. *pp.* 2610–2612, *Dec.*, 1936.—Not only are many important colloids truly stable in that they form spontaneously and enter into reversible equilibrium with crystalloidal constituents and crystals, but otherwise unstable colloids may also exhibit similar properties characteristic of true stability if sufficient stable protective colloid is present. AUTHORS.

**442. Aerosols. Part I. Conditions of Formation. N. N. Andrejew and S. G. Kibirkschtis.** *Kolloid Zeits.* 77. *pp.* 299–301, *Dec.*, 1936.—Aerosols are to be regarded not as two-phase but as three-phase systems, as it is essential for their stability that the particles in the disperse phase are covered with an oriented layer of the third substance (the stabiliser). Both the disperse material and the stabiliser must have polar molecules. Thus $NH_4Cl$, which forms a relatively stable aerosol in moist air, will not do so in dry air or in air containing $C_6H_6$ vapour; again, diphenyl will not form an aerosol even in moist air. L. V. C.

**443. Colloidal Copper and Alcoholic $Al_2O_3$-Gel. M. A. Miller.** *Kolloid Zeits.* 77. *pp.* 310–312, *Dec.*, 1936.—Colloidal Cu was prepared by Kutzelnigg and Wagner's method, *viz.* by precipitation upon Al immersed in a 2 % solution of $CuCl_2$ in 95 % ethyl alcohol; the colloidal Cu is readily dispersible in alcohol, the particle size being about 0·8 $\mu$. If this colloidal Cu or bulk Cu metal be placed in 95 % EtOH in contact with aluminium, a gel of hydrated $Al_2O_3$ slowly forms. This does not occur when pure water or EtOH is substituted. The Cu itself is unaffected, indicating an electrochemical mechanism of the reaction. L. V. C.

**444. Conductivity and Cataphoretic Speed of Benzopurpurin 4B, Congo Red and Sky Blue F.F. B. N. Acharya, A. M. Patel and B. N. Desai.** *Indian Acad. Sci., Proc.* 4*A*. *pp.* 503–513, *Nov.*, 1936.—Measurements of conductivity and cataphoretic speed of pure benzopurpurin 4B, Congo red and sky blue F.F. are made and it is found that on increasing the concentration of the dye solutions although the equivalent conductivity continuously decreases the cataphoretic speed increases regularly. The cataphoretic speed of benzopurpurin 4B first increases and then decreases with the progress of dialysis. On adding small increasing amounts of NaCl to benzopurpurin 4B and Congo red and $BaCl_2$ to sky blue F.F. the cataphoretic speed first increases and then decreases. The changes in conductivity and cataphoretic speed are explained on the basis of aggregation of the dye ions to form ionic micelles. It is shown that the process of dyeing of cotton fibre by substantive dyestuffs in the presence of salt can be easily understood on the basis of aggregation of dye ions. AUTHORS.

***445. Electroosmotic Measurements. A. Vašíček.** *Kolloid Zeits.* 77. *pp.* 305–310, *Dec.*, 1936.—Apparatus and technique are described for the measurement of electroosmosis (of KCl solutions) through the porous porcelain diaphragms previously studied [see Abstract 2702 (1935).] Measurements are made of (i) the total liquid transfer (electrolytic *plus* electroosmotic) expressed as l./F.; (ii) the relative conductivities of the electrolyte within and without the diaphragm; from these data the electrokinetic potential, etc., may be derived. L. V. C.

***446. Vertical Microelectrophoresis Cell with Non-Polarisable Electrodes. H. A. Abramson, L. S. Moyer and A. Voet.** *Am. Chem. Soc., J.* 58. *pp.* 2362–2364, *Dec.*, 1936.—The horizontal microelectrophoresis cell has not been adapted to the measurement of particles which settle out of suspension. A vertical cell has been devised which embodies all of the useful characteristics of the one-piece glass cell described previously by Abramson and discussed more recently by Moyer. This vertical cell has been checked by comparing measurements on protein-coated collodion particles, asbestos needles, and blood cells with measurements obtained in a calibrated horizontal cell and a U-tube. Agreement within the usual limits of experimental error was obtained. The advantages and disadvantages of the vertical cell are discussed. AUTHORS.

**447. Colloid Structure and Infra-Red Absorption Spectra. S. S. Bhatnagar, P. L. Kapur and M. D. Rajpal.** *Kolloid Zeits.* 77. *pp.* 281–286, *Dec.*, 1936.—The infra-red absorption spectra of hydrosols of $Fe_2O_3$, $As_2O_3$, $SiO_2$, $SnO_2$ and Au are investigated, the transmitted intensity being expressed as a percentage of that for a corresponding quantity of water. It is found that from about 0·9 to 1·3 $\mu$ and from about 1·55 to 1·75 $\mu$ the sols have a lower transmission than water, whereas from about 1·3 to 1·55 $\mu$ and above about 1·75 $\mu$ they have a greater transmission than water. This is thought to be connected with an effect of the colloid particles upon the degree of polymerisation of the water. Differences are observed between the absorption spectra of sols of hydrophobe and hydrophile character. L. A. W.

**448. Soap Solutions. Part I. Opacity. P. Ekwall.** *Kolloid Zeits.* 77. *pp.* 320–333, *Dec.*, 1936.—The appearance of opacity in such solutions as those of sodium stearate, palmitate, laurate, and oleate is nephelometrically determined for a wide temperature range and it is shown that under suitable conditions there are two regions of opacity sharply defined one from the other. The opacity formations depend on the products of hydrolysis; the lower opacity region depends on the formation of free fatty acid as the opacity-forming substance, while in the higher region the opacity is due to acidified soap. It is pointed out that the disappearance of the first opacity with increase of concentration is because the fatty acid formed by hydrolysis, for a given concentration combines nearly quantitatively with the neutral soap to form acid soap. The disappearance of the second opacity is put down to an increase in the degree of association of the soap substances which is presumed to lead to the formation of soluble soaps, probably rich in alkali. J. K.

**449. Effect of Concentration on Viscosity of Starch Pastes and Lyophilic Sols. W. Gallay.** *Canad. J. of Research*, 14. *Sect.B. pp.* 391–403, *Nov.*, 1936.—Acid-modified pastes of corn and potato starch exhibit a critical concentration, below which an equation of the Einstein form $\eta_\phi = \eta_0 (1 + a\phi)$ expresses the relation between viscosity and volume ratio $\phi$ of the disperse phase and above which, owing to the onset of structural flow, $\eta = KP^n/F$, F being the flow under pressure P and K and $n$ are constants for a given suspension; $n$ is a linear function of concentration. The high values of effective volume in these sols is regarded, following Haller, as being due to steric immobilisation of water in the tangled long-chain starch molecules, giving a resultant structure akin to that of an emulsion. L. V. C.

**450. Colloid Chemistry and Physics of Organic Plastic Masses. R. Houwink.** *Kolloid Zeits.* 77. *pp.* 183–201, *Nov.*, 1936.—After giving an introduction into the general mathematical principles underlying plastic and elastic deformation, both these types of deformation are considered with reference to intra- and inter- molecular forces. The main difference between purely elastic and highly elastic deformation is made clear and the various types of plastic-deformation curves are discussed. Due to the close relationship between plasticity and high elasticity it appears that four postulates have to be satisfied for high elasticity. Change of fluid into the solid state, cooling and polymerisation are discussed. Spheroid colloidal plastics are distinguished on cooling from linear colloidal plastics. Phenol-formaldehyde resins, oil polymerisation products and styrol are treated by way of example. The effects of active fillers and softeners on vulcanised rubber are also considered, as well as the influence of particle orientation and thixotropy on the properties of plastic masses. J. K.

**451. Intramicellar Swelling of Cellulose by Water. I. Sakurada and K. Hutino.** *Kolloid Zeits.* 77. *pp.* 346–351, *Dec.*, 1936.—By X-ray analysis it is shown that with cellulose fibres in water, washed alkali-free and not dried, there is obtained from sodium cellulose I a new and seemingly sharp diagram, which betokens the pentration of the water into the lattice of the cellulose itself. This " hydro-cellulose " is designated, to avoid misunderstanding, " water cellulose." The " water cellulose " is most marked in its shifting of the $A_1$ interference in the diagram. It is stable for an indefinitely long period at ordinary temperatures and also against mineral acids. The $A_1$ interference shift declines as the washing temperature rises of the sodium cellulose I. The following lattice constants are given for water cellulose : $a : b : c = 10.03 : 10.3 : 9.98.$, $\beta = 52°$, $V = 817.$ Å.$^3$ The penetration of the water causes the distance apart to widen from 101 whilst for hydro-cellulose ordinarily 101 and 002 remain unaltered. Similar widening of the lattice is seen with Li and K-cellulose as also with cellulose xanthate. " Water cellulose " swells in water more strongly than hydro-cellulose. S. G. B.

**452. Hydrophilic Properties of Cellulose. Part I and II. K. Kanamaru.** *Kolloid Zeits.* 77. *pp.* 351–365, *Dec.*, 1936.—By immersion of cellulose or cellulose derivatives in water the potential of these bodies decreases according to the following formulæ : $-(d\zeta/dt) = a(\zeta-\zeta_\infty)$ or $\log\{(\zeta_0-\zeta_\infty)/(\zeta-\zeta_\infty)\} = kt$ where $\zeta_\infty$ designates the value of the $\zeta$ potential when it approaches the $\zeta$ potential-time curve asymptotically, and $\zeta_0$ is the value of the $\zeta$ potential at the moment of immersion of the bone-dry, water-free preparation in water. The results show that for the absorption isotherm of water vapour and the simultaneous decrease of the $\zeta$ potential for cellulosic materials, the value $(\zeta_0-\zeta_\infty)$ is a measure of the hydration capacity, . . . . . . the value $(\zeta_0-\zeta)$ for the degree of hydration and $-(d\zeta/dt)$ indicates the velocity of hydration. Electropositive fibres, prepared from normal electronegative cellulose by adsorption of $Al(OH)_3$ at saturation, have in general, in comparison with normal untreated electronegative material, a smaller hygroscopicity and greater strength. The paper deals with the various aspects of these two properties and their production, as also their values. S. G. B.

**453. Retardation by Amino Acids of Thixotropic Solidification. W. Heller.** *Comptes Rendus*, 203. *pp.* 1507–1509, *Dec.* 28, 1936.—The delay in re-gelation of a thixotropic sol of $Fe_2O_3$ due to addition of an amino-acid, *e.g.*, glycocoll is due to retardation in evolution of the geloids [see Abstract 953(1936)] to a size sufficient to render them susceptible to centrifuging, though the disposition of the particles to form geloids does not appear to be diminished. Addition of glycocoll also prevents such sols from becoming rheopectic. [See Abstract 3254 (1935).] C. A. S.

**454. Photoelectric Determination of Mean Degree of Dispersion of Suspensions. E. Hoffmann.** *Kolloid Zeits.* 77. *pp.* 286–288, *Dec.*, 1936.—Photoelectric measurements show that suspensions of particle size from 2 to 30μ absorb light according to the equation $I = I_0e^{-Kc/r}$, where $I_0$ and I are the incident and transmitted intensities, $c$ the concentration, $r$ the effective radius of the particles and K a constant. This makes possible a simple and rapid method of determining mean degrees of dispersion for the control of the operation of colloid mills and the like. L. A. W.

*See also* Abstracts 411, 537, 619, 801, 802, 947.

## CRYSTAL STRUCTURE AND PROPERTIES.

**455. Lattice-Theory of Alkaline Earth Carbonates. Parts II and III. B. Y. Oke.** *Indian Acad. Sci., Proc.* 4*A*. *pp.* 514–530, *Nov.*, 1936.—The elasticity-constant $c_{jh}$ consists of two parts $c_{jh}^{e}$, due to the electrostatic forces and $c_{jh}^{r}$ due to the repulsive forces. Considering the crystal as built up of a system of parallel neutral planes, the electrostatic part of the elasticity-constant in a direction perpendicular to the system of planes, can be determined by considering the action on any one of the system of planes, of a few of its adjoining planes on one of its sides. $c_{11}^{e}$ and $c_{22}^{e\,0}$ are determined in this way. The nature of the repulsive forces is completely determined by the equilibrium condition and by comparison with the experimental value of $c_{11}$. The value of $c_{22}^{r\,0}$ is then determined. The theoretical and experimental values of $c_{22}^{0}$ are found to agree well. The lattice-energy of the crystals of calcite is calculated; and the value of $n$ the index of the repulsive forces is determined with the help of the compressibility measurements. The value of the lattice-energy is applied to a thermochemical cyclic process. [For Part I see Abstract 4469 (1936).] AUTHOR.

**456. Diffusion of Water through Agar Gels. L. Zobrist and M. Gruber.** *Kolloid Zeits.* 77. *pp.* 333–342, *Dec.*, 1936.—The method evolved for the determination of the quantity of pure water which diffuses through agar gels is fully described. The influence of saturation-deficit, temperature, direction of flow or position and agar concentration are ascertained. J. K.

**457. Barker's Principle of Simplest Indices. P. Terpstra and W. J. van Weerden.** *Zeits. f. Krist.* 95. 5–6. *pp.* 368–382, 1936. *In English.*—In connection with the application of the Barker rules to the triclinic system the authors investigate the problem of the possible number of different ways in which the 26 planes with indices containing no integer other than 0 or ±1 can be distributed. The method used is based on the work of Pólya. The total number of possibilities is found to be 552 and they are described in 13 tables. J. I.

**458. Crystal Structure Factor for the Regular Octahedron. M. v. Laue and K. H. Riewe.** *Zeits. f. Krist.* 95. 5–6. *pp.* 408–420, 1936.—Equations are given for expressing the structure factor of a regular octahedron. The geometrical form of these expressions is shown in a series of diagrams. It is confirmed that the distribution of intensity around each point of the reciprocal lattice has a marked peak in the direction perpendicular to the crystal face. J. I.

**459. Energy Bands for the Face-Centred Lattice. W. Shockley.** *Phys. Rev.* 51. *pp.* 129–135, *Jan.* 15, 1937.—The Slater method of obtaining wave functions for metallic lattices is applied to the face-centred lattice. The solutions previously obtained by Krutter for this lattice were mainly for certain simple lines in momentum space. Methods are developed for obtaining more general solutions from these special ones. On this basis the entire 110 plane is worked out. For certain new lines in this plane especially simple solutions are given. An approximate method suitable for calculating energy contours in momentum space for small values of momentum is developed. AUTHOR.

**460. Lattice Constants of Very Pure Aluminium. A. Ieviņš and M. Straumanis.** *Zeits. f. phys. Chem.* 34. *Abt. B.*5. *pp.* 402–403, 1936.—These constants reduced to 25° C. measured with Cu radiation, 7 mA, 40 kV and using an 86 mm. camera, the diameter of the preparation being 0·18 mm., were found to give as mean value 4·04147 ± 0·00001. They were determined only from the two lines 333 $\alpha_1$ and $\alpha_2$ which always give the best results. The final result of all the measurements of the authors for the lattice constant of the purest Al at 25° C. using wavelengths $k\alpha_1 = 1{\cdot}53740$ and $\alpha_2 = 1{\cdot}54123$ gives the value 4·04145 ± 0·00002 Å. The precision of the method is 0·0005 % (1 in 200,000). The thermal expansion coefficient of Al measured by means of three films between 25° and 45° C. was found to be $23{\cdot}29 \times 10^{-6}$, which is in good agreement with the earlier value $23{\cdot}13 \times 10^{-6}$. [See Abstract 3957 (1936).] J. J. S.

**461. Structure of Krennerite. G. Tunell and C. J. Ksanda.** *Washington Acad. Sci., J.* 26. *pp.* 507–509, *Dec.* 15, 1936.—X-ray examination of well-developed crystals from Cripple Creek (Colorado) show krennerite to be orthorhombic with *a* 16·51, *b* 8·80, *c* 4·45 Å with 8 molecules of $AuTe_2$ in the unit cell, space group $Pma - C_{2v}^4$, and thus definitely different from calaverite. A small portion of the Au is replaced by Ag, apparently in solid solution. [See following Abstract.] C. A. S.

**462. Morphology of Calaverite in Relation to its Internal Properties. G. Tunell and C. J. Ksanda.** *Washington Acad. Sci., J.* 26. *pp.* 509–528, *Dec.* 15, 1936.—The problem of the complex faces of calaverite is stated in detail with accounts of previous work and theories thereon. Borchert's view that it has undergone a polymorphic inversion, and that it and krennerite [see preceding Abstract] are merely high and low temperature forms of the same, is disproved; G. F. H. Smith's suggestion that the crystals are heterogeneous is improbable as it is shown that the heterogeneity, if present, is on a scale finer than microscopic. X-ray examination shows that the structural coincide with the morphological axes and axial ratios; that calaverite is monoclinic, the unit cell having *a* 7·18, *b* 4·40, *v* 5·07 Å, *β* 90° ± 30′, and containing 2 molecules; and that Donnay's hypothesis of two intergrown triclinic lattices is untenable. The complex faces are related to certain adventive diffraction spots in the X-ray spectra. A complete explanation for these spots and faces has not been found but it is thought to lie "not in the geometrical arrangement of the atoms in the unit cell, but in some type of subsidiary phenomenon of the crystals." C. A. S.

**463. Structure of Crystalline Bromine. B. Vonnegut and B. E. Warren.** *Am. Chem. Soc., J.* 58. *pp.* 2459–2461, *Dec.*, 1936.—Oscillation patterns about the $c$-axis were made of a Br crystal held at about − 150°. The lattice is orthorhombic with axes: $a = 4{\cdot}48$, $b = 6{\cdot}67$, $c = 8{\cdot}72$ Å. The 8 atoms are in the position 8$f$ of the space group *Ccma* ($V_h^{18}$), with $x = 0{\cdot}135$ and $z = 0{\cdot}110$. The structure is isomorphous with that of I, and shows a definite $Br_2$ molecule with Br–Br distance of $2{\cdot}27 \pm 0{\cdot}10$ Å. The X-ray density at about − 150° is 4·05.
AUTHOR.

**464. Polymorphism of Rochelle Salt. H. v. R. Jaffe.** *Phys. Rev.* 51. *pp.* 43–47, *Jan.* 1, 1937.—A careful analysis of the properties of Rochelle salt leads to the conclusion that this crystal belongs to the monoclinic hemimorphic symmetry class between the so-called Curie points (+ 23·7° C. and − 18° C.), whereas it is orthorhombic hemihedric at other temperatures. The Curie points are to be regarded as crystallographic inversion points like the high-low inversion points in quartz and other crystals. Dielectric anomalies as observed for Rochelle salt must be expected near inversions from a pyroelectric to a non-pyroelectric crystal glass. Other properties of Rochelle salt discussed in the light of the new classification are the electro-optic effect, the converse and the direct piezoelectric effect, and the specific heat. A comparison with symmetry conditions in ferromagnetic crystals is made. AUTHOR.

**465. Structure of Oxalic Acid Dihydrate. J. M. Robertson and Ida Woodward.** *Chem. Soc., J. pp.* 1817–1824, *Dec.*, 1936.—The structure of oxalic acid dihydrate is determined by a Fourier synthesis from the X-ray crystal data, absolute measurements of intensity for two zones of reflections being employed. Zachariasen's preliminary structure is confirmed, and more accurate values are given for the 12 parameters of the structure. A small difference in the C—O distances of the COOH group is indicated (1·24 and 1·30 Å), and the presence of the water O atom at 2·52 Å from one of the carboxyl O atoms indicates the formation of a true H bond. The other carboxyl O atom (probably the hydroxyl) is almost equidistant, at 2·87 and 2·84 Å, from two other water O atoms, distances which in this case indicate OH bonds. The C—C distance in the oxalic acid molecule is only 1·43–1·45 Å, indicating the presence of certain double-bond properties in this link, presumably due to conjugation of double bonds in adjacent COOH groups. This result offers an explanation of the invariance of the coplanar structure of the oxalate radical in the different crystalline modifications of the acid and its salts.
AUTHORS.

**466. Structure of Glycine. A. Kitaygorodsky.** *Acta Physicochimica*, 5. 5. *pp.* 749–755, 1936. *In German.*—A new X-ray study of glycine is described. The following data are given for the monoclinic unit cell: $a = 5{\cdot}08$, $b = 11{\cdot}9$, $c = 5{\cdot}43$ Å, $\beta = 111° 38'$; space group = $P2_1/n$; 4 mol. of $NH_2{\cdot}CH_2{\cdot}COOH$ per unit cell. These values agree with those of Hengstenberg and Lenel [see Abstract 2934 (1931)], but the present author disagrees with the molecular arrangement put forward in the earlier work and new atomic coordinates are tabulated. It is pointed out that if the comparison between calculated and observed intensities is restricted to the ($hk$O) and (O$kl$) planes both structures give fair agreement, but when the comparison is extended to include general ($hkl$) planes only the structure put forward by the present author gives calculated intensities in agreement with those observed. The following interatomic distances are given, C — C = 1·47, C — N = 1·40, C — O = 1·39 Å. J. I.

**467. Structure of Addition Compounds of Cholesterol. F. Klötzer.** *Zeits. f. Krist.* 95. 5–6. *pp.* 338–367, 1936.—The crystal structure of cholesterol and its addition compounds with water and certain organic solvents is investigated by means of the powder and single crystal methods. Crystals obtained from the melt are also studied. From an ethyl alcohol-ether solution the author obtains three different modifications which, although similar in their cell size, show different molecular arrangements. Two modifications are obtained from methyl alcohol-ether solutions. The author discusses the similarities which appear to exist between these structures and that of ergosterol. J. I.

**468. Solid and Anisotropic and Isotropic Liquid *p*-Azoxyanisol. P. Chatelain.** *Comptes Rendus,* 203. *pp.* 1169–1171, *Nov.* 30, 1936.—*p*-Azoxyanisol is monoclinic, $a : b : c = 1{\cdot}988 : 1 : 2{\cdot}590$, $\beta$ 106° 20′. The refractive indices $n_\alpha$, $n_\beta$, $n_\gamma$, for $\lambda$ 6500 are respectively 1·559, 1·568 and 2·148, and for $\lambda$5460 1·570, 1·580 and 2·275. It melts at 115° to an anisotropic liquid which becomes less so as the temperature rises, and completely isotropic at 134°. If $n_o$ and $n_e$ denote the ordinary and extraordinary indices of the anisotropic, and $n_{iso}$ that of the isotropic liquid the relation $\frac{1}{3}\left[\frac{n_e^2 - 1}{n_e^2 + 2} + 2\,\frac{n_o^2 - 1}{n_o^2 + 2}\right]\frac{1}{d} = \frac{n_{iso}^2 - 1}{n_{iso}^2 + 2}\cdot\frac{1}{d^1} =$ constant, which is also deduced theoretically from the orientation and polarisation of the molecules, is satisfied. C. A. S.

**469. Two Types of Diamond. R. Robertson, J. J. Fox and A. E. Martin.** *Roy. Soc., Proc.* 157*A*. *pp.* 579–597, *Dec.* 2, 1936.—Earlier work on the absorption spectrum [see Abstract 2291 (1934)] is extended over the region 4 to 4·8$\mu$ by further resolution of the band at 4·8$\mu$ and of the small band near to that at 8$\mu$ for Type 1. The tests of photoelectric properties were extended to 20° K, and at − 253° C. no abrupt change in the effects observed at − 160° C. were found. The bands of emission of the infra-red were tested over a wide range of temperature and were found to agree with the absorption bands so closely that even details of the structure of the bands are reproduced, confirming Kirchhoff's law over a range of wave-length and in a spectral region not usually tested. When air had access to the diamond at a temperature of 700° C. a finely etched surface with inverted pyramidal pits was obtained. Nernst and Eucken's method was used, and for both types of diamond the same specific heat was found throughout the critical range of low temperature and also at higher temperatures. R. S. R.

**470. Nucleus Formation and Recrystallisation. Part III. M. Kornfeld.** *Phys. Zeits. d. Sowjetunion,* 10. 2. *pp.* 142–153, 1936. *In German.*—Single crystals of Al are prepared and the orientation of a given face of the crystal is measured by means of X-rays. The number of nuclei on the face are counted and then the crystal is stretched and annealed (recrystallisation) and the number of nuclei again counted. It is found that the maximum velocity of growth occurs in directions which differ considerably from the preferred orientations. This result is discussed and a number of suggestions to account for it are offered. [For Part II see Abstract 984 (1936).] H. J. H. S.

**471. Ultramicroscopic Observations on Photosensitive Crystals. Part III. Thermal Processes. K. Schaum and A. Becker.** *Zeits. f. wiss. Phot.* 35. *pp.* 241–266, *Nov.–Dec.,* 1936.—A long review of the knowledge of photolysis and thermolysis is given. The individual processes possible in a crystal like KCl are discussed in great detail. The causes of lattice faults and the predominating influence of these on the photolysis and thermolysis are considered. A Born-Haber energy cycle for KCl is discussed. The influence of temperature is considered, and it is pointed out that the expected increase of amplitude of the lattice vibrations could have little effect on the rate of electron transfer from anion to kation. The results of the authors' recent observations on the thermolysis of various salts ($AgNO_3$, AgF, AuCN, $KAu(CN)_4$, $CuBr_2$, etc.) are given. Photographs of initial and advanced thermolysis are shown. [For Part II see Abstract 2720 (1934).] J. E.

***472. X-Ray Goniometer Using Beams of Large Aperture for Photographically Recording Crystal-Powder Reflections. J. C. M. Brentano.** *Phys. Soc., Proc.* 49. *pp.* 61–77, *Jan.* 1, 1937.—The factors which determine the various aberrations of X-ray reflections from microcrystalline powders are considered in relation to the design of a goniometer using beams of large aperture. Expressions are derived for the aberrations from a flat layer and from a toroidal powder surface in relation to the angular setting. An instrument using wide beams is described in detail and indications are given regarding its operation. According to the procedure adopted such aberrations as lead to asymmetrical diffusion effects are reduced, and in this way sharp lines with correctly located peaks are obtained. Powder layers with spherical and toroidal surfaces are discussed in detail and data are given for their use; as compared with flat layers they make it possible to employ considerably wider beams with correspondingly shorter exposures, particularly in the range of medium and large angles. AUTHOR.

*See also* Abstracts 430, 477, 532, 756, 758, 764, 765, 856, 876, 887, 902, 913, 914, 915, 916.

## DENSITY.

**473. Orthobaric Densities of Substances as a Function of Reduced Temperatures. H. A. Fales and Clara S. Shapiro.** *Am. Chem. Soc., J.* 58. *pp.* 2418–2428, *Dec.,* 1936.—The ratio of orthobaric densities is a function of reduced temperature and consequently the vapour volume can be expressed as a function of reduced temperature and liquid volume along the saturation line, namely, $\ln v_g/v_1 = k\,(1-\tau^2)^m/\tau^n$; $v_g = v_1 \exp. k\,(1-\tau^2)^m/\tau^n$. The constant $k$ of the suggested equation is almost identical with the critical coefficient $K_{cr}$, their ratio being nearly equal to unity for most substances investigated. The critical coefficient is not a constant but varies from substance to substance, increasing with the order of curves ($\ln v_g/v_1$) in the coordinate system. There seems to be a definite similarity in the mechanism of evaporation of substances as shown by the fact that the respective expansion curves can be expressed by one and the same equation and that the constants of this equation have values very close to each other for substances of the most diverse chemical and physical properties. AUTHORS.

*See also* Abstracts 535, 547, 763.

## DIFFUSION AND OSMOSIS.

***474. Diffusion Apparatus. N. S. Scheinker.** *Acta Physicochimica,* 5. 5. *pp.* 729–737, 1936. *In English.*—A diffusiometric vessel is designed, in which the method of obtaining a sharp interface between the solution and the solvent is based on an entirely new principle. Two modifications of such a vessel are proposed. The measuring parts of the Ostwald-Quast-Auerbach apparatus have been remodelled to fit the new type of diffusiometric vessel. Experimental data illustrating the reproducibility of the results are given. AUTHOR.

*See also* Abstracts 456, 496.

## ELASTICITY AND PLASTICITY.

**475. Simple Distribution of Stress in Three Dimensions. S. Ghosh.** *Calcutta Math. Soc., Bull.* 28. *pp.* 107–119, *June*, 1936. *In English.*—From the well-known equations of equilibrium of an isotropic elastic solid under no body forces a mathematical deduction is made of the distribution of stress in a cone to which a couple is applied at the vertex. J. T.

**476. Flexure of a Hollow Shaft. Part I. B. R. Seth.** *Indian Acad. Sci., Proc.* 4*A*. *pp.* 531–541, *Nov.*, 1936.—In the cases of a shaft having uni-axial symmetry, a solution is obtained for the flexure of a hollow shaft having an excentric cavity. The case of the axis of symmetry perpendicular to the plane of loading involves what is known as "associated flexural torsion." The other case considered is for the axis of symmetry in the plane of loading. Equations are written for the components of the displacement and stress and the values of the constants obtained mathematically in terms of the elasticity, inertia, etc. H. M. B.

**477. Strength of Brittle Substances. A. Smekal.** *Zeits. f. Physik*, 103. 7–8. *pp.* 495–525, 1936. *Ergeb. d. exakt. Naturwiss.* 15. *pp.* 106–188, 1936.—The first paper summarises the fracture theory of brittle bodies, and is a contribution to the structure problem of the solid state. The subject is dealt with under athermic fracture processes, and considers the plane plate with direct elliptical fissure, bodies with plane circular fracture, the influence of crack orientation, bodies with spherical cavity, and also with any other given form of fracture. Athermic fracture limits and elastic limits are investigated under two dimensional and spatial circumstances. Thermal tension fracture processes are finally considered, and all the theoretical results are compared with the experimental data. The more comprehensive second paper gives a very complete theoretical discussion of the fundamental mathematics of homogeneous and inhomogeneous bodies, of the strength properties of glasses (and on the nature of the glass state), and finally of crystals, concluding with a contribution to the problem of crystal plasticity. A Bibliography of 145 papers concludes the paper. H. H. Ho.

**478. Atomic Forces of the Solid State. Parts IV and V. Weng Wen-Po.** *Phil. Mag.* 23. *pp.* 33–49, *Jan.*, 1937.—This paper continues the work of Part III [see Abstract 3985 (1936)] and in it the equation, $K = 1\cdot5 \times 10^{-39}\,W^{\frac{1}{2}}\rho^{-\frac{1}{2}}\,\nu^{3}\,T^{-1}$ watt/cm./kc., is derived, where K is the conductivity, W the atomic weight, T the absolute temperature, and $\nu$ the infra-red characteristic frequency. A comparison of the calculated results for several alkaline halides with experimental data shows excellent agreement. In Part V the argument is extended to the liquid state and the formulæ : $S_m = 5\cdot0 \times 10^{-25}\nu^2 W$ dynes/cm. and $\nu^2 = 2\cdot0 \times 10^{-24}\,S_m/W$ are derived, where $S_m$ is the surface tension in dynes per cm. Data are given for Pb, Sn, Hg, Cd, Bi, Ca, Zn, A, Br, Cl, H, N, O, S and Se, and the agreement found to be quite good. H. H. Ho.

V. 19

**479. Characteristic Property of Saint-Venant's Solutions for the Torsion and Bending of an Elastic Cylinder. J. N. Goodier.** *Phil. Mag.* 23. *pp.* 186–191, *Jan.*, 1937.

**480. Variation of Internal Friction and Elastic Constants with Magnetisation in Iron. Part I. W. T. Cooke.** *Phys. Rev.* 50. *pp.* 1158–1164, *Dec.* 15, 1936.—A new and precise method is described for measuring the elastic constants and coefficients of internal friction of solid substances. The method is applied to investigate the variation of Young's modulus and the longitudinal coefficient of internal friction of annealed and unannealed Armco iron with magnetisation at room-temperature. Data are given which describe the behaviour of the iron in three different magnetic states, viz., at different points on the normal induction curve and on a hysteresis cycle, and in the anhysteretic state obtained when an alternating field, the amplitude of which is gradually reduced to zero, is superposed on a steady magnetising field. The observed coefficients of internal friction of the unannealed specimen require correction, and this, together with the torsional data and theoretical interpretation of the results, are given in Part II [see following Abstract]. AUTHOR.

**481. Variation of Internal Friction and Elastic Constants with Magnetisation in Iron. Part II. W. F. Brown, Jr.** *Phys. Rev.* 50. *pp.* 1165–1174, *Dec.* 15, 1936.—The experimental method described [see preceding Abstract] is applied to measure the variation of the rigidity modulus and torsional decrement with magnetisation in unannealed and annealed Armco iron. Formulæ are derived which evaluate the contributions to the moduli and decrements arising from eddy currents induced in the vibrating specimen by the change in magnetisation produced by the varying stress. These formulæ contain the magnetostriction and Wiedemann effect coefficients, which, accordingly, have been measured. All effects of the eddy currents are thus eliminated from the final data, which are discussed in the light of recent ferromagnetic theory. AUTHOR.

**482. Compressibility Determinations without Volume Measurements. E. S. Burnett.** *J. of Applied Mechanics*, 3. *A*136–*A*140, *Dec.*, 1936.—A new method described of determining the isothermal deviations of a real gas from compliance with ideal gas laws. This method eliminates all volume and mass measurements from the experimental observations, and permits calculation of the deviations from observations of pressures and temperatures only. AUTHOR.

**483. Penetration-Viscosity Relationship in Asphaltic Bitumens. R. N. Traxler and C. U. Pittman.** *J. of Applied Physics*, 8. *pp.* 70–71, *Jan.*, 1937.—The relation proposed by Saal and Koens between viscosity $\eta$ and penetration $p$, viz. $\eta = (5{\cdot}13 \times 10^9)/p^{1{\cdot}93}$, applies only to asphaltic bitumens exhibiting no elasticity, thixotropy or anomalous flow properties. These disturbing factors are seldom if ever simultaneously absent. Elasticity is frequently absent as shown by the independence of $\eta$ on shearing rate, but in deriving $p$ thixotropy is of importance, as is also the adhesion of the asphalt to the penetrometer needle. L. V. C.

**484. Effect of Age of Phenolite on the Coefficent of Photoelastic Extinction. J. Kuno.** *Phil. Mag.* 23. *pp.* 63–64, *Jan.*, 1937.—A series of tests has been made during the course of a year to determine whether the photoelastic phenomenon in phenolite is affected by the age of the material. The coefficient of photoelastic extinction is calculated for each of the six specimens by the method previously described [see Abstract 1392 (1935)]. There was a small variation, but so small that it may be concluded that the photoelastic property in phenolite is very little affected by the age of the material. The mean value of the photoelastic extinction is 12·57 ± 0·11 kg./cm. C. J. B. C.

***485. Condenser Pressure Gauge. C. H. Johansson.** *Ann. d. Physik*, 27. 8. *pp*. 742–752, *Dec.*, 1936.—Various arrangements of a cylindrical condenser are described which permit the measurement of high pressures by observation of the change in capacity of the condenser. With air or varnish as dielectric the capacity-pressure relation is linear, but slight hysteresis is observed with the former. The dependence of the value of the dielectric constant of mica and of other substances on the pressure is examined. F. C. C.

*See also* Abstracts 450, 532, 758, 779.

## GRAVITATION.

**486. Corrections to Newton's Law of Gravitation. J. Chazy.** *Comptes Rendus*, 203. *pp*. 1127–1130, *Nov.* 30, 1936.—Hély's theory of gravitation and electromagnetism [see Abstract 3523 (1936)] is examined. The conditions defining the planetary orbits are derived by means of an analogy with the principle of Maupertuis. Each orbit is shown to be that expected if the planet were acted upon by a force derived from the potential function $\mu/r + 3\mu^2/c^2r^2$, where $\mu$ is the Keplerian attraction coefficient, $r$ the distance from the sun, and $c$ the velocity of light. To the Newtonian inverse-square attraction must therefore be added an inverse-cube correction $-6\mu^2/c^2r^3$. This correction gives an advance of the perihelion of Mercury agreeing with observation. A. Hu.

**487. Gravitational Waves. A. Einstein and N. Rosen.** *Frank. Inst., J.* 223. *pp*. 43–54, *Jan.*, 1937.—The rigorous solution for cylindrical gravitational waves is given. For the convenience of the reader the theory of gravitational waves and their production, already known in principle, is given in the first part of this paper. After encountering relationships which cast doubt on the existence of *rigorous* solutions for undulatory gravitational fields, we investigate rigorously the case of cylindrical gravitational waves. It turns out that rigorous solutions exist and that the problem reduces to the usual cylindrical waves in Euclidean space. AUTHORS.

**488. Value of Gravity at Washington. P. R. Heyl and G. S. Cook.** *Bureau of Standards, J. of Research*, 17. *pp*. 805–839, *Dec.*, 1936.—An absolute determination of the value of gravity in the constant-temperature room in the second sub-basement of the East Building of the National Bureau of Standards has given the value 980·08 cm./sec$^2$. This determination was carried out with pendulums of fused silica, and special attention was directed to the flexure correction. AUTHORS.

## HYDRODYNAMICS AND AERODYNAMICS.

***489. Induction Pump for Liquid Mercury. E. S. Gilfillan, Jr. and S. M. MacNeille.** *Rev. Sci. Instruments*, 8. *pp*. 28–34, *Jan.*, 1937.—Difficulties are encountered with reciprocating pumps for the continuous circulation of mercury. An all-metal pump, without moving parts, operating on the principle of a polyphase induction motor is developed. The mercury flows in the annular region between two concentric tubes. Surrounding the tubes are coils connected to a polyphase supply. The result is a series of magnetic ripples travelling along the axis of the tubes which drag the mercury along by virtue of the currents induced in it. Lifts in excess of 1m. and capacities in excess of 50 c.c. per sec. have been obtained. AUTHORS.

*See also* Abstracts 545, 584.

## KINETIC THEORY OF MATTER.

**490. Kinetic Equation for the Coulomb Effect. L. Landau.** *Phys. Zeits. d. Sowjetunion*, 10. 2. *pp*. 154–164, 1936. *In German*.—The kinetic equation for a system arising from charged particles is derived by a consideration of their mutual action. From this equation is deduced the order of the mean free path of the particles as well as the velocity of temperature equilibrium. H. J. H. S.

**491. Nuclear Moments by the Molecular Ray Method. H. Kopfermann.** *Ergeb. d. exakt. Naturwiss.* 15. *pp*. 229–261, 1936.—This paper comprises a review of the molecular ray and atomic ray methods of determining nuclear moments and a critical discussion of the results of such determinations with comparison where possible with similar results obtained by the hyperfine structure method of investigation. The paper concludes with a list of some 50 references to publications relating to this field of research. J. E. K.

*See also Abstracts* 406, 501.

## LENGTH (STANDARDS, MEASUREMENTS, APPARATUS).

**492. Errors in Fractions of a Circle. F. Hauer.** *Zeits. f. Instrumentenk.* 56. *pp*. 442–459, *Nov*., 1936.—In continuation of an earlier paper [see Abstract 4533 (1936)] the mean errors in the diameter and amplitude are determined and the author's and Heuvelink's methods are compared. The methods are applied to some instruments with the fixed intervals of 45°, 36°, 30° and 10° and the results tabulated. Formulæ are derived for the periodic errors of fractions of circles and the results of the author's and Heuvelink's procedure are compared for mean diameter and amplitude errors. A comparison is given of the calculated periods with the measured differences and finally the results obtained by the two methods are contrasted. R. S. R.

**493. Homogeneous Scales for Pointer Instruments. H. Maurer.** *Zeits. f. Instrumentenk.* 57. *pp*. 26–29, *Jan*., 1937.—In certain types of pointer instruments it is necessary to read the position of the pointer in terms of divisions of a non-homogeneous scale, owing to the mode of operation of the measuring device. Thus a similar change of the measured quantity $\alpha$ at different parts of the scale corresponds to dissimilar changes of angular position $\omega$ of the pointer, where $\omega$ is some non-linear function of $\alpha$. It is possible to find curves on which the lengths of the intercepts between two positions of the pointer are linearly proportional to the difference between the corresponding indicated quantities, so that accurate linear interpolation between scale divisions becomes possible. For practical purposes a scale of circular form is retained, but the fiducial marks are shown on a zig-zag line. H. B.

*See also* Abstract 501.

## MASS (STANDARDS, MEASUREMENTS, APPARATUS).

*See* Abstract 437.

## MATHEMATICAL METHODS. THEORY OF MEASUREMENTS. UNITS AND DIMENSIONS.

**494. Recurrence Formulæ for Generalised Spherical Functions. B. Matula.** *Acta Physica Polonica.* 4. 4. *pp.* 419–426, 1935. *In German.* —In a mathematical note, recurrence formulæ are obtained for the generalised spherical functions ${}^{n}V_{l}^{m}$ $(x)$ which have been used by Tamm [see Abstract 341 (1932)] for the solution of the equation of motion of electrons in the field of an isolated magnetic pole. The case of $n = 1$ only is considered. Extension to other values of $n$ follows in an analogous manner. G. O. B.

**495. Shot Effect and Similar Fluctuations. E. N. Rowland.** *Cambridge Phil. Soc., Proc.* 32. *pp.* 580–597, *Oct.,* 1936.—The theory of random events whose effects are additive is studied from the point of view of mathematical rigour. The results are applied to the theory of light, to the simple shot effect and to the shot effect with secondary emission. G. C. McV.

**496. Properties and Applications of the Repeated Integrals of the Error Function. D. R. Hartree.** *Manchester Phil. Soc., Mem.* 80. *pp.* 85–102, 1935–1936.—Since the solutions of several one-dimensional problems in diffusion and heat conduction can be simply and conveniently expressed in terms of the functions formed by repeated integration of the error function, this paper gives such properties of these functions as are useful in these applications, with tables of functions which occur frequently, and examples of their application. The examples are: the temperature distribution in (1) a semi-infinite block when the rate of supply or loss of heat at the free face is kept constant, (2) a slab of finite thickness initially at 0° when heat is generated uniformly through the material and at a constant rate, the faces of the slab (plane and parallel) being maintained at 0°, (3) a semi-infinite block which has a plane face kept at 0°, the initial temperature of the block, and in which heat is generated at a rate depending linearly on the temperature. Modified forms of the equation of heat conduction are discussed. N. M. B.

**497. Physical Laws Expressible by "Statistical Chains." O. Onicescu.** *Comptes Rendus,* 203. *pp.* 1493–1495, *Dec.,* 1936.—Physical laws are interpreted in terms of what the author calls "statistical chains" of functions. G. C. McV.

**498. New Basic Critical Equations and Methods in the Calculus of Variations. W. S. Kimball.** *Phil. Mag.* 23. *pp.* 114–153, *Jan.,* 1937.

**499. Information Available in Small Samples. M. S. Bartlett.** *Cambridge Phil. Soc., Proc.* 32. *pp.* 560–566, *Oct.,* 1936.—Examples are taken of the case where the necessary sufficiency properties exist but where the actual formula for the amount of information is not applicable and the extent to which a formal representation of the information formula is still possible has been examined, allowing the use of the Dirac $\delta$ function. Finally a solution for testing the difference in means between two normal samples, with unknown variances given by Behrens and Fisher, where an extension of the fiducial argument is used, is examined and considered to be open to criticism. [See Abstract 1477 (1936).] R. S. R.

**500. Verification of the Hypothesis Relating to the Law of Probability of a Variable Chance. J. Neyman.** *Comptes Rendus,* 203. *pp.* 1047–1049, *Nov.* 23, 1936.—A variable chance $x$ is taken with

$n$ particular values furnished by independent observations. Then with the law of elementary probability of $x$ unknown the hypothesis H is verified such that the law is determined by a function $p(x)$. This is equivalent to the verification of another hypothesis, $h$, such that the law of probability of $y = \int_{-\infty}^{x} p(x)dx$ equals unity for $0 < y < 1$ and zero at other times. R. S. R.

**501. Limits of Measurability. W. Gerlach.** *V.D.I.* 81. *pp.* 2–7, *Jan.* 2, 1937.—The author presents a general review of the importance of precision in measurement and outlines methods by which the limits of measurability have been extended. Examples are given of the application of physical laws to this end, *e.g.*, the application of the theory of interference colours to the determination of thickness. Atomic physics and the quantum theory have extended the attainable limits. The reaction of the measured quantity on the measuring device often imposes a limit on direct measurements. The influence of the Brownian movement is discussed and illustrated in relation to the measurement of very small amounts of energy; and the measurement of atomic magnitudes is discussed. R. E. N.

**502. Rationalisation of Electrical Equations. L. Bouthillon.** *Soc. Franç. Élect., Bull.* 6. *pp.* 1175–1194, *Dec.*, 1936.—The author reviews known methods of rationalising Maxwell's equations [see Abstract 4538 (1936)] indicates new methods and discusses the merits and defects of each. The Lorentz equations have considerable importance for theoretical physics and the author discusses the effect of the various systems of rationalisation on the form of these equations and the relativist equations. Anomalies of the theory of magnetism are examined and A. Sommerfeld's suggestions are discussed. In dealing with the use of the tensorial notation for the exposition of the laws of electricity and magnetism, the author stresses the desirability of mathematical symbols conforming to the physical magnitudes, and emphasises the value of tensors in correlating theory and practice. R. E. N.

***503. Mechanical Solution of Simultaneous Equations. J. B. Wilbur.** *Frank. Inst., J.* 222. *pp.* 715–724, *Dec.*, 1936.—A description is given of a machine designed at the Massachusetts Institute of Technology for the mechanical solution of a set of not more than nine simultaneous equations with real coefficients. The machine lends itself to the solution of a larger number of equations provided certain restrictions in their form are met, and the theory on which the machine is based is such that a larger machine, capable of solving a larger number of equations directly, may be built. The operation of the machine is described and some discussion of the accuracy attainable is given. J. S. C.

**504. Representation of Parameter Functions by Electrical Methods. F. Lieneweg.** *Wiss. Veröff. a.d. Siemens-Werken*, 15. 3. *pp.* 92–108, 1936.—The general relations between a dependent and two independent variables are reduced, by graphical methods, to determinations of slope, or of change of slope, or of parallel displacement, of curves or straight lines derived from the original relations. These simple relations are then reproduced by electrical circuits arranged to perform operations equivalent to addition, subtraction, multiplication or division. Applications to measurements of conductivity of electrolytes, pH values, humidity, etc., are described. P. V.

*See also* Abstracts 493, 519, 918.

## MECHANICS, CLASSICAL.

**505. Perturbation Theory. W. Glaser.** *Zeits. f. Physik*, 104. 1–2. *pp.* 157–160, 1936.—A new method of treatment of perturbed mechanical systems is described. Unlike the Hamilton-Jakobi theory, it makes *direct* use of the Lagrange equations of motion. C. B. A.

***506. Short Foucault Pendulums. B. Dasannacharya and D. Hejmadi.** *Phil. Mag.* 23. *pp.* 65–88, *Jan.*, 1937.—The Foucault rotations of the plane of oscillation of pendulums are studied for pendulum lengths between 245 and 95 cm., and bob weights between 450 and 150 gm. Suspension by means of torsionless threads of silk or cotton is shown to overcome many of the difficulties of previous investigators. Experiments are made to investigate the errors introduced by different types of knot suspension, and the results are applied to the case of rigidly-fixed suspensions. The development of the elliptic orbit of the bob is discussed, and the part played by the suspension in favouring certain directions of vibration is emphasised. The theory of the Foucault pendulum is modified to take into account air resistance. Reasons for the growth of the ellipticity of the orbit at a rate far higher than that demanded by theory are suggested, and the application of the results to measurements of the earth's rotation is discussed. A. Hu.

***507. Temperature-Compensated Rod Pendulum. O. Meisser.** *Ann. d. Physik*, 28. 1. *pp.* 114–120, *Jan.*, 1937.—Quartz pendulums, used to measure microseismic changes in the soil near the sea coast (Oldenburg), are supported on quartz or steel knife edges and weigh 686 gm. and 766 gm. respectively. The problem is to increase the weight of the pendulums without altering their periods and to reduce the effect of temperature on their frequency. The pendulum rod is bored centrally and a solid added in such a position and of such an amount that both conditions are fulfilled. Each case is considered mathematically and for the first a purely geometrical condition is found between the lengths of the added and original substances and the position of the former. If tungsten is added to the original rod of quartz, the weight is raised to about 1·1 kg. and the temperature coefficient is reduced to less than 1/5 of its original value. H. M. B.

*See also* Abstracts 540, 554, 555, 556, 851.

## MECHANICS, QUANTUM.

**508. Differential Relations between the Dirac Spherical Functions. D. N. Masurenko.** *Phys. Zeits. d. Sowjetunion*, 10. 2. *pp.* 193–202, 1936. *In German.*—Although explicit solutions of the Dirac equations for an electron are well known in the case of a centrally symmetrical field and have been studied by several methods, the results are not well suited to practical calculations. In this mathematical paper, the Dirac equations are separated in polar coordinates, in an analogous manner to the separation of the Schrödinger equation. Simple relations for the parts of the eigenfunctions dependent on angle are obtained, which can be interpreted as relations between the components of rotational impulse. The results are suitable for the simplification of calculations with the eigenfunctions of angle. G. O. B.

**509. Saturation of Exchange Forces. E. Wigner.** *Nat. Acad. Sci., Proc.* 22. *pp.* 662–666, *Nov.*, 1936.—A proof, with its exact conditions, is given for the saturation property of Majorana and Heisenberg forces. N. M. B.

**510. Relativistic Quantum Mechanics. B. Kwal.** *Comptes Rendus*, 203. *pp.* 1132–1134, *Nov.* 30, 1936.—Continuing his previous work [see Abstract 83 (1937)], in which quaternary matrices are employed in relativistic quantum mechanics, the author expresses the uncertainty relation connecting position in space-time and the quantity of energy of motion, by means of quaternary matrices. The equations so obtained are discussed, and also their connection with the Heisenberg relations. G. O. B.

**511. Electronic Model in Dirac's Wave Mechanics. T. de Donder and J. Géhéniau.** *Comptes Rendus*, 203. *pp.* 1238–1240, *Dec.* 7, 1936.—The 16 fundamental equations of Dirac's wave mechanics are deduced for an electronic model considered as a particle of mass $m_0$ and charge $e$ subjected to a gravitational, an electromagnetic, and a wave field. N. M. B.

**512. Relativistic Quantum Mechanics of the Electron. A. Datzeff.** *Comptes Rendus*, 203. *pp.* 1240–1242, *Dec.* 7, 1936.—Analogies between classical and quantum relativistic mechanics are developed. N. M. B.

**513. Action-Function and Force on the Electron. Marie A. Tonnelat-Baudot.** *Comptes Rendus*, 203. *pp.* 1332–1333, *Dec.* 14, 1936.—It is shown how the expression for the force on an electron, proposed by Elenberg, is related to the action-function of Infeld and the energy-impulse tensor of Schrödinger. G. C. McV.

**514. Interpretation of the Phase in the Matrices of Quantum Mechanics. P. Soleillet.** *Comptes Rendus*, 203. *pp.* 1333–1335, *Dec.* 14, 1936.—It is suggested that certain combinations of the phases of the harmonic vibrations constituting a matrix in quantum mechanics ought to have a physical significance. G. C. McV.

**515. Positive Energy Wave Packet Solution of the Dirac Equation. C. Eckart and B. L. Griffing.** *Phys. Rev.* 50. *pp.* 1145–1147, *Dec.* 15, 1936.—A wave packet solution of the Dirac equation is obtained by the superposition of positive energy solutions only. The solution involves an arbitrary parameter, and it is shown that this can be chosen so that all three dimensions of the packet are less than $h/mc$. The possibility of constructing such a packet had been doubted. It is also shown that in the limit $\Delta x = 0$, $\Delta x \Delta p_x = 1\cdot 49h$. It is not known whether this is the smallest value for the uncertainty product, subject to the condition that only positive energy solutions are used in the construction of the packet, or whether some other solution might yield a still smaller value. AUTHORS.

**516. Geometry of Microscopic Space. Part I. A. March.** *Zeits. f. Physik*, 104. 1–2. *pp.* 93–99, 1936.—It is suggested that the distance between two points whose coordinates are denoted generically by $(x)$ and $(x + dx)$ should be taken to be $ds = \sqrt{g_{ik}\,dx^i dx^k} - \gamma$, where $\gamma$ is the "classical" radius of the electron, $e^2/mc^2$. This would give a lower limit to the coordinate-differences corresponding to points between which a metrical relation exists. G. C. McV.

**517. Relations of the Tensor-Calculus to the Spinor-Calculus. E. T. Whittaker.** *Roy. Soc., Proc.* 158*A*. *pp.* 38–46, *Jan.* 1, 1937.—In the space-time of special relativity the "dual" of an arbitrary six-vector (tensor of rank two) is defined. Six-vectors which are identical with their own duals and which have a null invariant are shown to have properties equivalent to spinors. In this way a correspondence between the tensor- and the spinor-calculus is established and it is explained how the latter simplifies certain complicated tensor operations. The tensor form of Dirac's equations for the electron is found and turns out to be equivalent to the vanishing of a vector. The method should yield a satisfactory generalisation of Dirac's equations to Riemannian space-time. G. C. McV.

**518. Wave Mechanics of Couples (Neutron-Neutrino). M. Born.** *Nature*, 139. *p*. 68, *Jan*. 9. 1937.—By a generalisation of Dirac's method, the author develops a theory of the emission of electrons in atomic transformations, as a special case of processes in which a pair of particles (neutron and neutrino) is evolved, the principal feature being that the rest-mass of a single particle is not conserved, but only that of the pair as a whole. The theory represents the electromagnetic forces and the nuclear " exchange " forces by the same formalism.

**519. Law of Limiting Probability in a System of Contingent Variables. J. Neyman.** *Comptes Rendus*, 203. *pp*. 1211–1213, *Dec*. 7, 1936.—A statistical theorem is developed. N. M. B.

**520. Statistical Mechanics of Condensing Systems. Part I. J. E. Mayer.** *J. Chem. Phys*. 5. *pp*. 67–73, *Jan*., 1937.—It is shown that for a system composed of $N$ identical molecules with mutual potential energy, the assumption that the total potential energy can be expressed as the sum of that between pairs of molecules allows the derivation of simple, accurate formal equations for the thermodynamic properties of the system. Under certain conditions, generally fulfilled at low temperatures, the equations predict a region where the pressure and Gibbs free energy are independent of volume, the characteristic of condensing systems. The equations permit calculation of the Gibbs free energy of the liquid in equilibrium with the vapour and all the properties of the saturated vapour, but not the volume or volume dependence of the condensed phase. [See following Abstract.] AUTHOR.

**521. Statistical Mechanics of Condensing Systems. Part II. J. E. Mayer and P. G. Ackermann.** *J. Chem. Phys*. 5. *pp*. 74–83, *Jan*., 1937.—It is shown how the quantities entering into the equations for the thermodynamic functions of a saturated vapour [see preceding Abstract] may be calculated. It is necessary to evaluate certain integrals which enter into the final expressions as the terms of an (almost) infinite, but rapidly convergent series. The first two of these integrals are evaluated with fair accuracy for a gas obeying the inverse seventh power law of force attraction. The third integral is estimated. The coefficients with which these integrals enter into the final expression are also estimated. The results of the calculation are compared with the experimental values for $CO_2$ and $CH_4$. Specifically, the volume of the saturated vapour in units of the volume of the molecules, and the ratio (PV)/(RT) for the saturated vapour are calculated on an arbitrary temperature scale. The agreement between the calculations and the experimental values is encouraging. AUTHORS.

*See also* Abstracts **432, 494, 527, 532, 776.**

## RELATIVITY AND ETHER.

**522. Superluminar Velocity. O. Garavaldi.** *N. Cimento*, 13. *pp*. 366–369, *Aug.–Sept.–Oct*., 1936.—One of the first postulates of the theory of relativity is the absolute impossibility of a velocity greater than that of light. A number of cases are discussed which seem to support the idea of a velocity which exceeds that of light, but it is concluded that this is due entirely to the choice of the system of reference, and that the limitation of superluminar velocity is a fundamental law. C. J. B. C.

**523. Kinematics and Group-Theory. V. Lalan.** *Comptes Rendus*, 203. *pp*. 1491–1493, *Dec*. 28, 1936.—The Lorentz transformation is established by means of the theory of groups. G. C. McV.

**524. Lens-Like Action of a Star by the Deviation of Light in the Gravitational Field. A. Einstein.** *Science*, 84. *pp*. 506–507, *Dec*. 4, 1936.—It is proved that the bending of the light rays coming from one star by the gravitational field of another, causes an observer to see the former as a luminous circle round the latter. The brightness of the first star is also enhanced. These theoretical predictions are much too small to be checked by observation. G. C. McV.

**525. Generalisation of Schwarzschild's Problem. B. Datta.** *Zeits. f. Physik*, 103. 7–8. *pp*. 546–550, 1936.—The internal solution of Einstein's gravitational equations for a spherical static distribution of matter is found for the case when the radial and transverse components of stress are unequal. G. C. McV.

**526. Complex Representation in Born's Field Theory. B. S. M. Rao.** *Indian Acad. Sci., Proc.* 4*A*. *pp*. 575–589, *Nov*., 1936.—The equivalence of Schrödinger's and Born's representations of the latter's field theory is established directly by means of analytical transformations, and in two other ways. A study of the invariants in the two original representations reveals two other alternative complex representations. [See Abstract 2864 (1935).] N. M. B.

**527. Lorentz Transformations in the New Quantum Electrodynamics. L. Infeld.** *Roy. Soc., Proc.* 158*A*. *pp*. 368–371, *Jan*. 15, 1937.—The relativistic invariance of the commutation rules is proved in a simple way by introducing the tensor $M^{kl}$, the components of which are integrals of the motion. AUTHOR.

**528. Lorentz Equation of Motion in the New Electrodynamics. Z. Chraplywyj.** *Acta Physica Polonica*, 4. 4. *pp*. 395–404, 1935. *In English*.—The equation of motion of a charged particle, analogous to the Lorentz equation, is worked out in the electrodynamic theory of Born and Infeld. G. C. McV.

**529. Definition of Distance in the Theory of Relativity. J. le Roux.** *Comptes Rendus*, 203. *pp*. 1236–1238, *Dec*. 7, 1936.—It is shown that there corresponds to the Lorentz equation an ellipsoidal wave. The assumption that all these waves are spherical leads to Poincaré's definition of length and the principle of the constancy of the velocity of light. N. M. B.

*See also* Abstracts 487, 510, 553, 554, 558.

## SOLUTION.

**530. High-Molecular Substances in Solution. F. Eirich and H. Mark.** *Ergeb. d. exakt. Naturwiss*. 15. *pp*. 1–43, 1936.—This very comprehensive paper first deals with the reciprocal effects between solvent and dissolved substances, and, under direct methods, considers the non-dissolving space, the colour sheath of cobalt salts, freezing out conditions, vapour pressure measurements and dielectric constants; under indirect methods, the deviations from the van't Hoff law, diffusion and viscosity are reviewed. A very comprehensive discussion is given of the experimental data. The reciprocal effects of the dissolved particles are next dealt with under (A) particle dispersions in which the heats of dilution, further solution and viscosity are considered; and (B) particle associations, in which flow anomalies, molecular weight determinations and various other methods are discussed. A very complete Bibliography of 242 references completes a very valuable publication. H. H. Ho.

**531. Theory of Binary Solutions. K. Fredenhagen.** *Zeits. f. Elektrochem.* 43. *pp.* 28–42, *Jan.*, 1937.—An extension of the paper by E. Hückel [see Abstract 5020 (1936)]. F. J. B.

*See also* Abstract 637.

## SURFACE TENSION AND COHESION.

**532. Quantum Mechanical Discussion of the Cohesive Forces and Thermal Expansion Coefficients of the Alkali Metals. H. Fröhlich.** *Roy. Soc., Proc.* 158*A*. *pp.* 97–110, *Jan.* 1, 1937.—A method is developed which allows the quantitative analytical calculation of the binding of alkali metals, using as only empirical parameter the ionisation potential. With this method the lattice constant, heat of sublimation, compressibility, and thermal expansion coefficient have been calculated. Satisfactory agreement with the experimental values is obtained. AUTHOR.

**533. Surface Tensions and Partial Vapour Pressures of Aqueous Aniline Solutions. J. C. Speakman.** *Chem. Soc., J. pp.* 1662–1668, *Nov.*, 1936.—The surface tensions and the partial vapour pressures of aniline are measured for aqueous solutions containing (*a*) NaCl (which has a salting-out effect), (*b*) aniline hydrochloride (which has an opposite "salting-in" effect), and (*c*) both these solutes together. The experimental data obtained are discussed. J. K.

**534. Surface Tension of Solids. R. N. J. Saal and J. F. T. Blott.** *Physica*, 3. *pp.* 1099–1110, *Dec.*, 1936. *In English.*—A critical description is given of the various methods proposed for the determination of the surface tension of solids. It is argued that none of these methods can give a reliable determination. P. H. B.

**535. Surface Tensions, Densities, Free Surface Energies and Parachors of Derivatives of Benzylated Phenols. D. T. Ewing and Frances W. Lamb.** *Am. Chem. Soc., J.* 58. *pp.* 2454–2456, *Dec.*, 1936.—Surface tensions and densities of 13 new derivatives of benzylated phenols are determined, and their molal free surface energies and parachors evaluated. AUTHORS.

**536. Surface Films of the Resinols and Allied Substances. F. A. Askew.** *Chem. Soc., J. pp.* 1585–1593, *Nov.*, 1936.—The constitutions of mono- and di-hydroxy-, of keto- and carboxyl-substituted derivatives of the resinols and sterols are discussed in the light of the surface pressures and surface potentials of 18 compounds of the resinol type, studied in the form of unimolecular films spread usually on $N/50$ HCl at 16°–20° C. Compounds having two or more polar groups widely separated in the molecule may give films in which only one polar group is attached to the water, but as the water-attracting power of the groups is made more nearly equal, the molecules may assume an orientation in which more than one polar group is attached to the water. The phenomenon of unstable initial films and of contraction, shown by many of the compounds studied, is discussed at length, but no general solution to this problem is reached. L. V. C.

**537. Experimental Investigation of Laminar Systems. Part IV. S. G. Mokruschin and P. S. Konjaew.** *Kolloid Zeits.* 77. *pp.* 301–305, *Dec.,* 1936.—The rate of increase of thickness of the initially invisible films of cupric hydroxide, which form in air on the surface of solutions of cuprammonium sulphate, was studied [see Abstract 1466 (1935)]. These films, whose formation is due to evaporation of $NH_3$ and hydrolysis of the complex, are permeable to air and $NH_3$; they exhibit interference colours by which their thickness up to 4000 Å (third order colours) was estimated, employing as refractive index the figure 1·66 found by a study of the reflection-polarisation properties of the films. Their thickness grows linearly with time, the rate of growth being greater the greater the concentration of the initial $CuSO_4$ solution, the $NH_3$ excess and the incident airstream. Their formation is accelerated also by rise of temperature, but they become non-uniform, due to CuO formation, above 50° C.

L. V. C.

**538. Rupture Phenomena of Liquid Drops. Part II. T. Tsutsui.** *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 662. *pp.* 227–237, *Dec.,* 1936. *In English.*—Continuing the work previously outlined [see Abstract 5 (1932)], the author has studied the time-changes in the diameter of a drop of water after impact with a horizontal surface. A full kinematographic record would require at least 1000 exposures per sec.; the method has therefore been adopted of recording a continuous trace of the diameter only (drop symmetrical) upon a revolving drum. If a spherical drop of radius $R_0$ impinges with velocity $v$ on a flat surface, the radius $R$ of the spread drop at a subsequent time $T$ is give by $R^3 = R^3_0[1 + K(v-v_0)T]$, $v_0$ being a critical velocity and $K$ being a constant depending upon the physical properties of the liquid and the nature of the solid surface. The photographic trace shows evidences of time-variations in the thickness of the spread drop from point to point, concerning which certain speculations are made.

L. V. C.

**539. Determination of Surface Tension. G. Duch.** *Comptes Rendus,* 203. *pp.* 1336–1338, *Dec.* 14, 1936.—Liquid (density $\rho$, surface tension T) is allowed to run slowly down the outside of an open capillary tube (external dia. D = 5 to 7 mm.) so that it eventually drops from the lower end of the tube, which is finished perpendicular to the axis. Then $H = (2T/\rho g)(1/r + 1/R)$ where H = distance from the meniscus inside the tube to the lowest point of the liquid surface immediately after a drop has fallen, $r$ = internal radius of the tube, and R = radius of liquid surface remaining at the bottom of the tube. R is calculated from D and the distance of the bottom of the tube from the lowest point of the liquid surface. For relative measurements $T_1 = T_2 \times H_2\rho_2/H_1\rho_1$ when the same value of R is concerned, and the author has observed that R is constant (*a*) at the beginning of the formation of a drop and also (*b*) when the meniscus in the tube is at the highest point attained, at which moment the drop is hemispherical.

P. H. B.

*See also* Abstracts 408, 411, 478.

## TIME (STANDARDS, MEASUREMENTS, APPARATUS).

***540. Accurate Time Measurement. A. Scheibe.** *Ergeb. d. exakt. Naturwiss.* 15. *pp.* 262–309, 1936.—After dealing with the necessity of measuring short time intervals to high accuracy, and with the time services which are available, the more successful pendulum clocks which have from time to time been devised are discussed. The development of quartz clocks is then dealt with. The Reichsanstalt quartz clocks are described and reference is made to the Marrison crystal clock. The observations made with these clocks are discussed. P. H. B.

***541. Pendulum Clocks. J. Hartmann.** *Zeits. f. Instrumentenk.* 56. *pp.* 438–442, *Nov.*, 1936.—Earlier time signals with these clocks at La Plata were often unreliable. The main features, action, and method of observation are described and the sources of error in the old installation are given. In the new housing a room of constant temperature is arranged with an electric thermostat to regulate it to 23·5° C., the average maximum temperature. Curves show the large improvement in accuracy of time signals. R. S. R.

***542. Electrically-Driven Tuning Fork as Source of Constant Frequency for Precise Measurement of Short Intervals of Time. R. B. Dow.** *Am. Phys. Teacher,* 4. *pp.* 199–200, *Dec.*, 1936.—The device consists of an elinvar 60-cycle tuning fork driven and amplified by a valve circuit capable of an output in excess of 3 W. The amplifier is a standard class A, push-pull type capable of high output with about 10 % distortion. Over a period of 24 hr., the average variation of frequency per hr. is about 0·002 %, a constancy much greater than that of commercial a.c. power sources. The oscillator is designed for continuous operation at full power output without any of the troubles usually associated with forks that operate by magnetic coils and electrical contacts. A self-starting, Warren telechron motor connected to the output is a satisfactory clock for the device. AUTHOR.

***543. Clocks Showing Mean and Sidereal Time Simultaneously. F. Hope-Jones.** *Frank. Inst., J.* 223. *pp.* 95–100, *Jan.*, 1937.—This paper describes a number of clocks which, by means of suitable trains of gears, give simultaneous readings on two dials of both mean and sidereal time, derived ultimately from a single pendulum beating either mean or sidereal seconds. Various gear ratios which have been suggested since 1800 are discussed and details are given of a train of wheels suggested by L. J. Comrie, giving $(45 \times 71 \times 257)/(29 \times 151 \times 187) = 1{\cdot}002\,737\,909\,297$, which is the true value of the ratio of sidereal to mean time in 1955. J. S. C.

## VACUA, HIGH.

***544. High-Vacuum Technique. W. Kerris.** *A.T.M. No.* 65. *T*153–*T*154, *Nov.*, 1936.—A summary of the salient points in vacuum technique, including a short treatment of rotary and diffusion pumps, some account of the meaning of pumping speed and its measurement, a discussion of the absorption of gases in silica and metals and vacuum-distillation. A comprehensive Bibliography is appended. G. E. B.

## VISCOSITY, FRICTION AND LUBRICATION.

**545. Friction at the Surface of a Solid Moving in Water. E. Brun.** *Comptes Rendus,* 203. *pp.* 1126–1127, *Nov.* 30, 1936.—A brief description of experiments on the temperature taken up by a disc rotating in water, and on the energy dissipated by friction. S. G.

**546. Viscosity of Saturated Methane-Oil Solutions under Pressure. J. Versluys, A. Michels and J. Gerver.** *Physica,* 3. *pp.* 1093–1098, *Dec.*, 1936. *In English.*—The method employed is that of the falling cylinder, a brass cylinder falling through the liquid in a glass tube. Near the start and end of the fall the cylinder lies between a pair of brass rings constituting condenser electrodes in a circuit just off resonance with an oscillator; resonance occurs at these two points and the change in output is employed to start and stop a stopclock. A table of solubility of $CH_4$ in (mineral) oil, unspecified, and of the density and viscosity of the saturated solutions is given, covering the ranges 25°—150° C. and 0—220 atm. L. V. C.

**547. Viscosity of Aqueous Solutions as a Function of Concentration. Part IV. G. Jones and R. E. Stauffer.** *Am. Chem. Soc., J.* 58. *pp.* 2558–2560, *Dec.,* 1936.—The absolute density and relative viscosity of many solutions of potassium ferrocyanide are determined at 0 and 25°, covering a range of concentration from extreme dilution nearly to saturation. The "Grüneisen effect" is especially pronounced in this salt of high valence type. The Jones and Dole equation is found to fit the data. The results confirm approximately the equation of Falkenhagen for the computation of the influence of interionic attraction on the viscosity. [For Part III see Abstract 2575 (1936).] AUTHORS.

**548. Oiliness of Liquids. Part II. Friction Coefficients of Films of Mono- and Poly-Molecular Layers. H. Akamatu and J. Sameshima.** *Chem. Soc., Japan, Bull.* 11. *pp.* 791–796, *Dec.,* 1936. *In English.*—The static friction coefficients have been measured for mono-molecular films of fatty acids, etc., deposited on a glass surface and for palmitic acid and oleic acid, when the film thickness increases from one to several molecular layers. The friction coefficient of the monomolecular film is about one-tenth of that of the clean glass surface. The value shows no further reduction by the increase of the thickness of film. Regular arrangement of oil molecules in the film gives a lower friction coefficient than irregular arrangement. [For Part I see Abstract 112 (1937).] AUTHORS.

*See also* Abstracts 480, 481, 483, 530.

# ASTRONOMY AND ASTROPHYSICS.

## ASTRONOMICAL APPARATUS AND OBSERVATORY EQUIPMENT.

***549. New Spectrograph of Potsdam Astrophysics Observatory. W. Herrmann and H. Brück.** *Zeits. f. Instrumentenk.* **56.** *pp.* **459–463,** *Nov.*, **1936.**—Full details are given of a spectrograph of large dispersion used with a reflecting telescope. The optical parts are shown in section, and by means of plates, and electron metal was used for lightness. Spectra of stars of magnitude 7 can be obtained with 2 hr. exposure of plates.
R. S. R.

***550. Effect of Object Brightness on Telescope Efficiency. M. Nagel and A. Klughardt.** *Zeits. f. Instrumentenk.* **56.** *pp.* **495–502,** *Dec.*, **1936.**—Continuing previous work [see Abstracts 3517 and 4244 (1936)], the authors examine the relation between the brightness $B$ of an object and the efficiency, as before defined, with which it is seen with the naked eye ($L_1$) and with a telescope ($L_2$). The curves connecting $L_1$ and $L_2$ with log $B$ each break up into 3 straight lines, corresponding to vision by the retinal rods at low values of $B$ ($< 0{\cdot}06$ apostilbs), by the cones at high values ($> 1{\cdot}8$ asb.), and by a mixture of rods and cones at intermediate values. The telescope efficiency $L=L_2/L_1$ is also plotted against log $B$: it shows peculiarities near the 2 transition points, rising sharply at $B = 0{\cdot}04$ asb. and showing a marked depression at $B = 2$ asb. This latter minimum is, however, removed by applying a suitable correction to the values of $L_2$, the adjusted telescope efficiency then giving the same constant value for both rod-and-cone and pure cone vision. It is suggested that the physiological explanation of the " light-concentrating effect " of telescopes is bound up with the mechanism of cone vision. A. Hu.

***551. Biprism for Stellar Interferometry. E. M. Thorndike.** *J.O.S.A.* **27.** *pp.* **51–54,** *Jan.*, **1937.**—It is shown that a biprism producing deviations proportional to the wave-length will be of value in stellar interferometry. The design, construction, and testing of an instrument employing such a biprism made of crown and flint glasses is described.
AUTHOR.

*See also* Abstract 543.

## COMETS AND METEORS.

**552. Velocities of Meteor Streams. M. Davidson.** *Roy. Astron. Soc., M.N.* **97.** *pp.* **75–76,** *Nov.*, **1936.**—The author criticises McIntosh's paper on the determination of meteor velocities [see Abstract 3520 (1936)] on the ground that an error made in a fundamental formula invalidates the method. A. Hu.

## COSMOGONY.

**553. Size of the Universe and the Fundamental Constants of Physics. A. Haas.** *Science,* **84.** *pp.* **578–579,** *Dec.* **25, 1936.**—The author discusses the possibility of determining the total mass of the matter in the universe on the assumption that the gravitational energy of the universe is not greater than its proper energy. The mass would be $10^{56}$ gm. G. C. McV.

**554. Kinematics, Dynamics and the Scale of Time. E. A. Milne.** *Roy. Soc., Proc.* 158*A. pp.* 324–348, *Jan.* 15, 1937.—The theorems of rational dynamics, derived in earlier papers [see Abstracts 2067 and 3460 (1936)], without recourse to the empirical laws of dynamics or gravitation, were expressed in terms of kinematic time $t$ as independent variable. It is shown that the equation of motion and all derivative theorems pass into the empirical Newtonian forms when the independent variable $t$ is transformed to a new variable $\tau$ given by $\tau = t_0 \log (t/t_0) + t_0$, where $t_0$ is the present value of $t$, *i.e.*, the age of the universe reckoned from the natural origin of time. When the graduations of a clock keeping kinematic time $t$ are re-numbered from $t$ to $\tau$, all physical quantities such as position-vectors, forces, angular momenta, the constant of gravitation, which have been defined fundamentally in terms of time-determinations, have new measures on the $\tau$-scale, and it is shown that it is the $\tau$-measures which occur in the transformed equations and theorems. It follows, by comparison of rational dynamics with empirical experience, that in classical dynamics the independent variable is $\tau$, not $t$. We are thus led by rational argument to a conjecture once made by de Sitter. Macroscopic time-keepers such as a pendulum, a rotating earth, or a revolving planet, keep dynamical time $\tau$ when their parameters are supposed constants on the $\tau$-scale, but atoms and radioactive clocks keep kinematic time $t$. A variety of dynamical and cosmological consequences are investigated. In particular, the prevalence of angular momentum in the universe at large is explained, and the natural origin of time is shown to be inaccessible by a sequence of dynamical phenomena traced backwards. AUTHOR.

## DYNAMICAL PROBLEMS (ASTRONOMICAL).

**555. Anomaly in Theory of Orbits. M. Subbotin.** *Comptes Rendus (Doklady) de l'Acad. des Sciences, U.S.S.R.,* 4. 4. *pp.* 175–178, 1936. *In French.*—It is shown how a general anomaly can be found in the theory of central orbits which includes as special cases, the eccentric, true and tangential anomalies. G. C. McV.

**556. Stellar Problem of Three Bodies. Parts I and II. E. W. Brown.** *Roy. Astron. Soc., M.N.*97. *pp.* 56–66, *Nov.,* 1936.—The stellar problem of three bodies is studied with the object of limiting the solution to those terms which may be capable of detection by observation. The assumption made is that no periodic term which contains as a factor of its coefficient the squares or products of the ratio of the periods and that of the mean distances can be detected by observation. A literal satellite theory is shown to be adaptable to the solution of this problem and the method avoids the use of infinite series so that the expressions obtained can be used for almost any values of the eccentricities and inclination. G. C. McV.

*See also* Abstracts 486, 506.

## NEBULÆ.

**557. Dynamics of Radiation Pressure for a Diffuse Nebula. H. Zanstra.** *Roy. Astron. Soc., M.N.*97. *pp.* 37–56, *Nov.,* 1936.—A formula for the pressure of radiation in an expanding nebula, corresponding to a general distribution of the velocity of the nebula as a function of the optical depth, is worked out. Using this formula the dynamics of the motion of a diffuse nebula are discussed. When the theory is compared with the observed state of motion of the Orion Nebula it appears that this nebula is probably still opaque to the L$\alpha$ radiation. The velocity of expansion deduced is 30 km./sec. as against the observed value of 25 km./sec. G. C. McV.

**558. Radial Velocity of the Extra-Galactic Nebulæ. P. Drumaux.** *Ann. Soc. Sci. de Bruxelles*, 56. *pp.* 327–341, *Dec.* 23, 1936.—The author solves in series Einstein's gravitational equations for the coefficients of the metric under the assumption that these coefficients depart slightly from unity. Having found a few terms of the series, in the case when the coefficients depend both on space and time coordinates, he re-discovers the well-known result that such approximations are sufficient to account for the radial velocity of the extra-galactic nebulæ. G. C. McV.

**559. Rotation of Planetary Nebulæ. R. d'E. Atkinson.** *Astrophys. J.* 85. *pp.* 1–8, *Jan.*, 1937.—The angular momentum possessed by rotating planetary nebulæ is greater than they could have possessed when their radii were small; it must have been acquired after they became large, or concurrently. It is shown that line absorption probably plays a much larger part than has hitherto been supposed, and that in that case the interaction of the Doppler effect due to spin with an Einstein red shift will darken the star's disc unsymmetrically, as seen by a nebular atom, and hence will give all such atoms a transverse component of momentum. The angular momentum thus acquired is sufficient to account for the observed velocities if the nebular mass is not more than about ten times that of the earth. The nebula and star rotate in opposite directions, but angular momentum is not conserved for the system considered apart from the stellar radiation emitted into space. AUTHOR.

## PLANETS.

*See* Abstract 577.

## STARS.

**560. Stellar Parallaxes Determined Photographically at the Cape Observatory. (Eighth List.)** *Roy. Astron. Soc., M.N.* 97. *pp.* 79–86, *Nov.*, 1936.—The form of publication is similar to that of previous lists. [See Abstract 507 (1936).]

**561. Stellar Parallaxes Determined at the Royal Observatory, Greenwich.** *Roy. Astron. Soc., M.N.* 97. *pp.* 86–89, *Nov.*, 1936.—A continuation of the results obtained with the 26-inch Thompson refractor. [See Abstract 506 (1936).]

**562. Absolute Magnitudes of Stars of Large Proper Motion. A. van Maanen.** *Mt. Wilson Observat. Contrib. No.* 562. *Astrophys. J.* 85. *pp.* 26–39, *Jan.*, 1937.—The total number of stars with proper motions exceeding $0''\cdot 5$ annually is estimated to be about 2380. For 651 of these stars parallaxes are known. These results have been used to derive the mean parallaxes for stars of different magnitudes and proper motions. The distribution of the absolute magnitudes of the 2380 stars was then derived. The maximum frequency is at about $+10\cdot 3$. Is is further shown that these stars must include practically all with parallaxes exceeding $0''\cdot 158$. In our immediate neighbourhood we find then about 1 star per $0\cdot 2$ cubic parsec; in this region the maximum of the luminosity-curve is at about $+12\cdot 7$. AUTHOR.

**563. Velocity Ellipsoid and General Star-Streaming in the Region around the Sun. B. Lindblad.** *Roy. Astron. Soc., M.N.* 97. *pp.* 15–24, *Nov.*, 1936.—A general expression for the velocity distribution in a region of the stellar system in terms of the integrals of the " local " orbits is given. The special cases of ellipsoidal and stationary distributions are considered. The normal velocity ellipsoid demanded by the rotation theory of the galaxy is discussed, and the deviations from this ellipsoid are classed as " secular " and " accidental." The secular variations depend on differences between widely different phases in the " relative " orbits, the accidental on variations in the region between motions of nearly the same phase. Neglecting the accidental variations, which are assumed to cancel out when computing the moments of the velocities, the secular variations will appear as disturbing streams through our regions. A development of the stream theory starting from general features of the stellar system is given in adherence to earlier work. The high-velocity stars, the distribution of the groups of B stars in our neighbourhood and the local disturbances in the differential rotation are briefly discussed and shown to be phenomena in general accordance with the theory. [See Abstract 3089 (1936).] AUTHOR.

**564. Distribution of Absorbing Atoms in Reversing Layers of Stars and Formation of Blended Absorption Lines. P. Swings and S. Chandrasekhar.** *Roy. Astron. Soc., M.N.* 97. *pp.* 24–37, *Nov.*, 1936.—The distribution of the absorbing atoms of specified ionisation and excitation is investigated as a function of the optical thickness of the stellar atmosphere, chiefly for the purpose of explaining why absorption lines appearing in the wings of other lines have peculiar intensities not derivable from the usual formulæ. The conditions for radiative equilibrium in a sharply stratified atmosphere give an adequate formula for this effect. It is assumed that in the A-type stars examined the $Ca^+$ absorbing atoms occupy the upper part of the reversing layers and that in the B-type stars the absorbing H atoms overlie ionised O atoms. G. C. McV.

**565. Spectroscopic Observations of V Canum Venaticorum. A. H. Joy and P. W. Merrill.** *Mt. Wilson Observat. Contrib. No.* 559. *Astrophys. J.* 85. *pp.* 9–13, *Jan.*, 1937.—30 spectrograms of the irregular variable V Canum Venaticorum have been obtained, mostly in 1935 and 1936, at various phases of the light-change. The velocity ranges for emission and absorption are 5·5 and 8·1 km./sec. respectively. The displacement of the emission lines toward the violet with respect to the absorption lines averages 6·3 km./sec. The spectrum changes very little during the period. H emission lines persist throughout, but are somewhat weaker at minimum. $H\gamma$ and $H\delta$ are nearly equal in intensity and stronger than $H\beta$. The spectral type varies from $M_4$ to $M_6$. AUTHORS.

**566. Revised Spectral Types of a Group of Stars in Kapteyn Area 98. M. L. Humason.** *Mt. Wilson Observat. Contrib. No.* 560. *Astrophys. J.* 85. *pp.* 14–17, *Jan.*, 1937.—*Mount Wilson Contribution* No. 458 gives the spectral types, classified from slitless spectrograms, of 4066 faint stars in selected areas 1–115. 2·5 % of these stars were classified as type B, approximately one-half of which (45 stars) were found in area 98. Since it was difficult to distinguish a B-type from an early F star when the spectra were too weak to show the H and K lines of Ca, the group classified as B in area 98 has recently been reobserved with a small-scale slit spectrograph. The reclassification of these stars shows that with few exceptions they are of types A or F. With the possible exception of the 57 stars classified as B in other areas, the revision in no way questions the spectral types assigned to the remaining stars of the catalogue. It does mean, however, that among the 4066 stars observed the frequency of class B stars is less than 0·5 %. AUTHOR.

**567. Origin of the Constellations. (Mrs.) A. S. D. Maunder.** *Observatory*, 59. *pp.* 367-375, *Dec.*, 1936.—Neither the positions nor their risings and settings of the constellations as given by Aratos in the *Phaenomena* agree with his epoch or latitude (41° N.), but they do agree with an epoch, about 2900 B.C., and a N. lat. 37°–38°. This latitude bars the observers from belonging to any of the great river civilisations (Nile, Euphrates or Indus) and it is claimed on this and other (non-astronomical) grounds that they were from the common ancestors of the Indo-European peoples; that they already knew the solstitial and equinoctial colures, the ecliptic and equator; that they framed the constellations round the important astronomical features of the ecliptic and the Milky Way; and that the figures themselves were mnemonic only. AUTHOR.

**568. Spectrum of Nova Lacertae. H. Camichel.** *Comptes Rendus*, 203. *pp.* 1130–1132, *Nov.* 30, 1936.—Preliminary results are given from plates showing the region from H$\alpha$ to H$\beta$ obtained during the period 19 June to 9 July, 1936. Changes in the contours of the H lines are described and discussed. Tables show the wave-lengths, the corresponding radial velocities, and the identifications for (*a*) the absorption lines in the pre-maximum stage, and (*b*) the emission lines in the post-maximum (nebular) stage. The spectrum is contrasted with that of Nova Herculis. The conspicuous appearance of the interstellar lines $D_1$ and $D_2$ is attributed to the Nova's great distance and to its low galactic latitude. A. Hu.

**569. Variations in the Spectrum of $\gamma$ Cassiopeiae. D. Chalonge and H. Safir.** *Comptes Rendus*, 203. *pp.* 1329–1332, *Dec.* 14, 1936.—The paper presents results obtained since the star's increase of brightness in July, 1936. Microphotometer curves show that the intensity of the H emission lines relative to the continuous background, and that of the continuous emission beyond the Balmer limit, have greatly increased. The progressive disappearance of the absorption line λ3888 of He is deduced from the fact that H$\zeta$ at λ3889 has gradually attained its normal intensity. The star's photographic magnitude, as determined by comparing the intensity of its radiation at λ4250 with the corresponding quantities for $\alpha$ Cygni and $\alpha$ Andromedæ, shows little change. A rough estimate of the colour temperatures $T_1$ and $T_2$ deduced from the continuum intensities at $\lambda > 3700$ Å. and at $\lambda < 3700$ Å. respectively gives values near 10,000°, as compared with the Sept., 1935, values $T_1 = 12{,}500°$, $T_2 = 14{,}000°$. A. Hu.

**570. Motion of Masses of Gas near Novae. R. Minkowski.** *Mt. Wilson Observat. Contrib. No.* 561. *Astrophys. J.* 85. *pp.* 18–25, *Jan.*, 1937.—On the assumption that the absorptions in the spectra of Novae arise in a thin expanding shell of gas surrounding the star, the size of the observed outward accelerations can be explained by radiation pressure. The interpretation of the observed inward accelerations as gravitational effects leads to stellar masses ranging up to several hundred solar masses. This indicates either that the hypothesis of the thin expanding shell cannot be maintained or that the motion of the gases near Novae is governed not by radiation pressure and gravitation alone but by some additional force such as might be due to a magnetic field of the star. AUTHOR.

**571. Franklin-Adams Chart. 3rd Edition.** *Roy. Astron. Soc., M.N.* 97. *pp.* 89–94, *Nov.*, 1936.—The 206 Franklin-Adams chart plates, taken with a 10-in. refractor of 45-in. focus, give good images over a

field, 15° × 15°, on a scale of 20 mm. to a degree, and afford a photographic representation of the whole sky on a uniform system. They were photographed: (1) on the southern sky at the Cape Observatory during 1903–4; (2) on the northern sky at Godalming, during 1905–9; and again on the southern sky at the Union Observatory, Transvaal, after 1910. They were discussed statistically at the Royal Observatory, Greenwich, and published as a memoir of the R.A.S., with copies of the charts on a reduced scale. Near the centre of the original plates, the limiting magnitude is 17·5, which is reduced towards the edges, and in the reproduction by $\frac{1}{10}$ and $\frac{1}{2}$ magnitude respectively. A table is given of the plate centre positions, of the dates of exposures and of the estimated number of stars.
A. S. D. M.

**572. Correlation between Attributes of a Star. R. A. Robb.** *Roy. Astron. Soc., M.N.* 97. *pp.* 67–75, *Nov.,* 1936.—A survey of the relations between various attributes of a star is made by using the general formulæ of linear regression. The attributes considered are (1) absolute magnitude $M$, (2) total linear tangential velocity $P$, (3) distance $r$, (4) apparent magnitude $m$, (5) proper motion $\mu$, and (6) the characteristic $H = m + 5 + 5\log_{10}\mu$. Assuming that $M$ and $r$, $P$ and $r$ are independent, a series of regression lines is derived. From the regression between $M$ and $H$, it seems feasible to obtain mean absolute magnitudes without the use of parallaxes: the quantities required depend only on the values of $m$ and $\mu$. Numerical instances are given to illustrate the use of the formulæ. An example shows how, by observational selection, correlations may be unwittingly introduced between characteristics elsewhere assumed independent. In particular, it is shown that certain discrepancies noticed in the results for A2 stars are removed when an accidentally introduced correlation between $H$ and $r$ is allowed for. The effect of accidental errors is investigated by means of regression lines.
A. Hu.

*See also* Abstracts 551, 779.

## SUN.

**573. Motions of Prominences. M. Notuki.** *Phys. Math. Soc. Japan, Proc.* 18. *pp.* 598–622, *Nov.,* 1936. *In English.*—The radius vector $r$ of a point in an eruptive prominence is expressed as a power-function of the time $t$ thus: $r = r_0 + \dot{r}_0(t - t_0) + \ddot{r}_0(t - t_0)^2/2!$, the subscript referring to the origin of observation. The numerical values of the constants are calculated from the results of Bobrovnikoff and Pettit [see Abstracts 761 and 4174 (1932)]: $\dot{r}_0$ is often negligible in the earlier stages of the life of a prominence, $\ddot{r}_0$ in the later. The mean velocity $V$ is best represented by an expression of the form $V^2 = ar^2 + br^{-1} + c$, where the first term predominates. These results are explicable if a radial repulsive force proportional to $r$ overwhelms gravitation and other effects having the same functional form. The radial motion of the outer shell of a hot expanding spherical mass is considered. The author examines what bearing different assumptions as to the distribution of density and temperature in such a shell have on the case of eruptive prominences. The nature of prominences and the origin of the forces causing their motion are discussed.
A. Hu.

**574. Solar Coronal Spectrum in 1936. B. Lyot.** *Comptes Rendus,* 203. *pp.* 1327–1329, *Dec.* 14, 1936.—Out-of-eclipse solar coronal observations were made at Pic du Midi during June–August, 1936 [see

Abstract 1554 (1936)]. The spectrographs are described for wave-length measurements, which are of (3rd order) 3300–3700 Å, and 3900–4350 Å, (2nd order) 5050–8600 Å, and (1st order) one plate 10,200–11,300 Å. All plates are taken with a circular slit, having the sun masked out and leaving a ring of the corona within 30 in. from the limb ; the east and west regions being photographed simultaneously up to latitudes, 70°. The spectrum showed as circular arcs, streaked by (1) large hazy bands due to coronal continuous spectrum, and (2) narrow defined ones due to continuous prominence spectrum ; allowing these to be discriminated. A table of 10 coronal lines (4 new) is given ; one in the infra-red is identified with line 7892 seen by Babcock in the eclipse of 24 Jan., 1925. The rotation of the corona was observed ; the wave-length of the west limb exceeded that of the last limb on two occasions by values similar to the sun's rotation. A. S. D. M.

***575. Comparison of Pyrheliometers. C. É. Brazier.** *Comptes Rendus*, 203. *pp.* 1009–1011, *Nov.* 16, 1936.—This investigation confirms previous work of a similar type [see Abstract 4922 (1934)]. The observations were made in June and July 1934 at Paris with three different instruments. A silver disc instrument served as standard. Of the other two, the aperture of one was varied and a comparison then made between the results obtained from the two for different altitudes of the sun and different transparency coefficients, *p*. The author finds (1) that for good transparency a reduction of the aperture from 19° to 16° lowers the indications of the instrument about 1 % and (2) that for a given altitude of the sun the lowering is greater the smaller *p*, while for constant *p*, it is greater the lower the sun's altitude. It is concluded therefore that for a strict comparison or two instruments the openings must be identical ; if the apertures are different, results vary with *p*. For comparison of two instruments it is therefore necessary to find the variation of the ratio of the results from the two instruments as a function of the aperture and transparency. A. E. M. G.

**576. Relative *f*-Values for Lines of FeI. D. H. Menzel and L. Goldberg.** *Astrophys. J.* 85. *pp.* 40–41, *Jan.* 1937.—In connection with R. B. and A. S. King's recent intensity measurements of FeI absorption lines in furnace spectra [see Abstract 535 (1936)], the omission of a weight factor in reducing equivalent widths to relative *f*-values is noted. In order to yield true *f*-values, the values as published must be divided by the statistical weight of the lower level. AUTHORS.

# GEOPHYSICS.

## GEODESY.

**577. Figures of the Earth and Moon. H. Jeffreys.** *Roy. Astron. Soc., M.N.* 97. *pp.* 3–15, *Nov.*, 1936. *Roy. Astron. Soc., M.N., Geophys. Supplement.* 4. *pp.* 1–12, *Jan.*, 1937.—De Sitter's theory of the figure of the earth is somewhat unsatisfactory because it assumes hydrostatic conditions within the earth, which do not hold. It has been corrected for the relativity effects, and it is found that the main ellipticity effects at any rate do not show significant departures from the theory. A rediscussion of the data for the moon's motion has been carried out, using only the theory of the field outside the earth. A geophysical analogy shows that the moon must be nearly homogeneous. The data are found to be consistent with the value $0{\cdot}87 \pm 0{\cdot}06$ for the ratio $f$ in the moon; the earth's ellipticity is found to be $1/296{\cdot}38 \pm 0{\cdot}51$, and the corresponding gravity formula is $g = 978{\cdot}051\{1 + (0{\cdot}005282 \pm 0{\cdot}000006) \sin^2 \phi - 0{\cdot}000007 \sin^2 2\phi\}$. It is believed that the apparent accuracy of this formula is genuine as far as the term in $\sin^2 \phi$ is concerned, and that other formulæ may be in error by larger amounts on account of failure of the methods of analysis to allow for other terms. The ratio $C/Mb^2$ for the earth is $0{\cdot}3345 \pm 0{\cdot}0012$. The ellipticities of the moon have been evaluated. It appears that their high values cannot be explained on the supposition that the moon solidified when already keeping the same face to the earth, but they can be explained if it was rotating freely in about 3·5 days. AUTHOR.

**578. Figure of the Earth from Gravity Observations. W. D. Lambert.** *Washington Acad. Sci., J.* 26. *pp.* 491–506, *Dec.* 15, 1936.—Mainly historical. An account is given of the work of Newton, Clairaut and Stokes regarding the determination of the general and detailed figure of the earth. This is followed by one of tables recently published by the Coast and Geodetic Survey which provide means of estimating the indirect effect on gravity of irregular distribution of mass, such as that of the relief of the earth's surface. C. A. S.

## GEOPHYSICS, APPLIED.

**579. Magnetic Intensity over a Major Geologic Structure. L. F. Uhrig and S. Schafer.** *Gerlands Beitr. z. Geophys.* 49. 1–2. *pp.* 129–139, 1937. *In English.*—The authors compare the observed and calculated values of the vertical and horizontal components of the magnetic field along a profile across the Los Angeles Basin. A structural geologic cross-section compiled from seismic, gravity and geologic data was used as a basis for calculating the magnetic field. In the San Pedro hills portion of the cross-section the calculated and observed values disagree, indicating that the granitic basement rocks lie at greater depths than shown in the structure section. AUTHORS.

## LAND, PHYSICS OF THE.

**580. Plastic Deformation of Soil. N. Miyabe.** *Tokyo Univ. Earthquake Research Inst., Bull.* 14. *pp.* 543–552, *Dec.*, 1936. *In English.*

—In a preliminary investigation into subsidences in Tokyo and Osaka, the bending and torsional strength of the surface soil were determined, and load-deflection and deflection-time curves for wet and dry soil obtained. A "visco-elastic" relation of the form $aS + bS^2$ was obtained for the deflection, where $S =$ load applied and $a$ and $b$ are constants; $b$ is proportional to the reciprocal of the viscosity, which was thus found to be greater in dry than in wet soil. Hysteresis effects also were observed. [See Abstract 2922 (1935).] R. F. A.

**581. Deformation of Sand Masses Due to Vertical Loads. N. Miyabe.** *Tokyo Univ. Earthquake Research Inst., Bull.* 14. *pp.* 553–559, *Dec.*, 1936. *In English.*—Sand contained in a box was compressed by a plunger applied to a small area by a weighted lever, and load-deflection curves were plotted. The results did not fit the formulæ of Rankine and Caquot for the bearing power at a given depth, and it is suggested that the discrepancy may be due to changes in the internal arrangement, number of contacts, etc., of the particles. The effects of grading and tightness of packing of the sand, and of applying the load at different distances from the edge of the box were examined. R. F. A.

**582. Elastic Constants of Soils. Part I. Young's Modulus. M. Ishimoto and K. Iida.** *Tokyo Univ. Earthquake Inst., Bull.* 14. *pp.* 632–657, *Dec.*, 1936. *In English.*—By a method somewhat resembling that of Ide [see Abstract 4468 (1935)] Young's modulus, the velocity of longitudinal waves, and solid viscosity of four soils near Tokyo (silt, loam, clay and silty clay), obtained by boring from depths of 2–20 m., were determined for all the soils after being remoulded into prisms 20–40 × 4 × 5 cm., and also of two from similar prisms cut directly from the block of soil as brought up. The value of all the constants is usually greater for soils in their natural state than when recomposed, they also decrease with increased moisture content. Those of Young's modulus ($\times 10^8$) were: silt (recomposed) 0·847–32·1; loam (natural) 5·76–10·4, (recomposed) 1·37–15·1; clay (recomposed) 2·40–19·0; silty-clay (natural) 0·561–17·4, (recomposed) 0·142. C. A. S.

***583. Kjellman Soil-Testing Machine.** *Engineering*, 143. *pp.* 10–11, *Jan.* 1, 1937.—The machine is illustrated and described. It enables the effect of each (or all) of three mutually perpendicular pressures of determinate amount on the sides of a specimen of soil in cubical form to be measured. An example (quartz sand) is worked out in detail. C. A. S.

**584. Movement of Desert Sand. R. A. Bagnold.** *Roy. Soc., Proc.* 157*A*. *pp.* 594–620, *Dec.* 2, 1936.—The motion of sand grains and their reaction on the air stream when wind blew over a thick layer of dry uniform sand on the floor of a wind tunnel was investigated experimentally. The paths of the individual grains were photographed. The wind velocity distribution and the pressure drop were measured during the sand movement and compared with results obtained over the same surface when movement was prevented. At the same time the total mass flow of sand past various sections of the tunnel was measured directly. The grain motion was found to consist of a series of bounds and sufficient impact was gained to splash up more grains into the air stream. The wind velocity at a height comparable with the surface sand ripple is constant after sand movement starts and is a function of grain diameter. The drag due to sand movement was found to be a maximum at the height above the surface at which maximum acceleration of the grains occurs. These drag values agreed with those calculated from the pressure drop along the tunnel and from the normal velocity distribution curves. The length of the characteristic path from impact to impact equals the measured wave-length of the surface ripples formed. R. S. R.

## METEOROLOGY.

**585. Absorption Coefficients of Ozone and Temperature of Upper Atmosphere. É. Vassy.** *Comptes Rendus*, 203. *pp.* 1363–1365, *Dec.* 14, 1936.—The coefficients of absorption of $O_3$ at the minima in the Huggins bands were redetermined under higher dispersion between − 80° C. and + 20° C. [see Abstract 3118 (1936)] and revised values of the ratios at these two temperatures are given. It is found that over this range of temperature the absorption coefficients at the minima vary linearly with temperature. The temperature of the $O_3$ at different heights in the atmosphere is deduced, the mean being placed at about − 30° C. D. H. F.

**586. Atmospheric Pressure Changes and Singularities of the Impulse Density Fields. H. Ertel.** *Preuss. Akad. Wiss. Berlin, Ber.* 20. *pp.* 257–266, 1936.—The Shaw assumption of a gradient wind corresponding automatically to a wind flow adjusted to the horizontal pressure gradient is used to provide a particularly simple explanation of atmospheric changes by means of the unsteadiness of the impulse density fields. These occur at true discontinuities, limits of air masses, surfaces of wind changes, and the tropopause. It is shown mathematically that these singularities of the impulse density fields can be conceived solely as the seat of the observed atmospheric pressure changes. R. S. R.

**587. Counting Particles Suspended in Air. Ouang Te-Tchao.** *Comptes Rendus*, 203. *pp.* 855–857, *Nov.* 3, 1936.—Smoke and dry air are mixed in definite proportions and are ionised in a chamber by Po. The small ions are first extracted. The large ions pass through a charged cylindrical condenser and part of them reaches the electrodes. Assuming a fixed charge for each particle and measuring the total charge received on the electrodes, the number ($n$) of the particles removed is obtained. The fraction ($f$) of the total number of particles (N) initially present is measured photoelectrically by the degree of opacity resulting before and after their extraction and $f = n/\mathrm{N}$. R. S. R.

**588. Visibility of Small Smoke Columns. G. M. Byram.** *Monthly Weather Rev.* 64. *pp.* 259–264, *Aug.*, 1936.—Tests were made in the Pacific N.W. region of U.S.A. to obtain data regarding the maximum distance smoke columns were visible under varying conditions of haze brightness, transparency of the air, intrinsic brightness of backgrounds, relative positions of sun and smoke columns, shadows in valleys with low sun, cloudiness of sky, and size of the smoke column. It was found that (1) small smoke columns can be seen farther looking into than away from a low sun but the reverse holds for trees, etc ; (2) in sunlight at the maximum distance of visibility from the observation point, the locus of the position of a smoke column is circular, and the radius increases as the brightness of the background decreases ; (3) towards a low sun visibility distance does not change greatly with intrinsic background brightness ; (4) from indirect observations and theory smoke columns are seen farther on cloudy than on clear days and especially against light backgrounds but for opaque objects little difference exists ; (5) safe visibility distance of smoke columns in shadows is zero for a low sun ; (6) small changes in size of smoke body have little effect on visibility distance ; and (7) in very clear weather small changes in atmospheric conditions cause large changes in visibility distance. R. S. R.

***589. Light Extinction Factor and Visibility by the Air Turbidity Measurer. V. Šaronov.** *Comptes Rendus (Doklady) de l'Acad. des Sciences, U.S.S.R.* 4. 3. *pp.* 131–134, 1936. *In German.*—An apparatus was described earlier to obtain the specific atmospheric turbidity. The use of the apparatus is extended to obtain the light extinction factor, and the visibility of objects. Formulæ are derived for these two quantities in terms of measurable values. For extinction coefficients dark objects such as woods or wooded hills on the sky line should be used. Allowance is made in the apparatus for differences in contrast of object and background and angular dimensions of the object but for visibility measurements the object should not subtend less than 3°. R. S. R.

***590. Comparison of Records of Two Anemometers. W. C. Kaye.** *Meteorolog. Office, Prof. Notes, No.* 74. [9 *pp.*], 1936.—The object of this comparison was to test the validity of Hellman's formula for variation of wind with height when applied to a coastal exposure. The actual heights are 59 ft. and 42 ft., the effective heights 50 ft. and 33 ft. The period investigated extends from May, 1934, to Feb., 1935. Winds for the four summer months, May to August, are treated separately from those of the winter period, Nov. to Feb. The results are divided into 8 groups according to direction, and the ratio $(V-v)/V$ determined in each case. $V$ and $v$ are the velocities recorded by the two instruments. This is compared with the value obtained by Hellman's formula. Reasonable agreement is found between the two sets. The variation of $(V-v)/V$ with speed as well as with direction is also tested. Here also fair agreement with the formula takes place. The author concludes that the application of Hellman's formula to the Southport exposure gives results suitable for ordinary meteorological purposes. A. E. M. G.

***591. Thermoelectric Anemometer. K. Wassiliew.** *Techn. Phys., U.S.S.R.* 3. 10. *pp.* 893–904, 1936. *In English.*—The hot end of a thermopile is fixed on the wire of a thermal anemometer, the cold end on a massive body in the air stream. The hot wire used has a resistance practically independent of temperature. King's formula giving the heat lost per unit length of wire is employed. This permits the deflection on a galvanometer scale obtained in a wind of velocity $V$ to be expressed in terms of that in still air, in the form $n = n_0/(1 + \sqrt{V^*})$ where $V^* = V/W$ ; $W$ is called the characteristic of the anemometer. The influence of temperature and pressure on the observations is discussed. Observations carried out with different currents on the heating wire and different velocities of air stream are considered. The author concludes that a thermal anemometer with a thermoelement is a satisfactory instrument for measurement of air stream velocities. Tables and diagrams illustrate the paper.

A. E. M. G.

*See also* Abstracts 567, 936, 937.

## SEISMOLOGY.

***592. Earth Vibrations. G. Angenheister.** *Ergeb. d. exakt. Naturwiss.* 15. *pp.* 310–364, 1936.—Methods are given by which vibrations are excited in the earth, whether naturally or artificially, with descriptions of the instruments used for artificial production, and for their recording.

This is followed by an account of the various waves produced by earthquakes or otherwise, with the effect thereon in causing reflection and refraction by discontinuities in the earth's crust and core. The inferences to be drawn from waves caused by suitably placed explosions as to the structure of the crust are described in considerable detail, with a table of velocities of waves mechanically produced in various sedimentary rocks or deposits. C. A. S.

**593. Love-Waves in a Triple Surface-Layer. R. Stoneley.** *Roy. Astron. Soc., M.N., Geophys. Supplement,* 4. *pp.* 43–50, *Jan.,* 1937.—The theory of the propagation of Love-waves is worked out for a triple surface-layer resting on uniform material. An outline is given of the method of proof that such waves can exist for the distributions of density and rigidity postulated, and it is shown that in certain circumstances waves with nodal planes may exist. A special application of the theory is made to the question of determining the thickness of the sedimentary layer of the continents when the densities, rigidities and thicknesses of the granitic and intermediate layers are known, and likewise the densities and rigidities of the sedimentary layer and of the ultrabasic material that lies beneath the continents. A range of likely values of the rigidity of the sedimentary layer gives, for the most part, a thickness round about 3 km. [See also Abstract 2944 (1935).] AUTHOR.

**594. Origins of Earthquakes. W. Inouye.** *Tokyo Univ. Earthquake Research Inst., Bull.* 14. *pp.* 582–598, *Dec.,* 1936. *In English.*—The initial motions of dilatational waves generated from a seismic origin are studied theoretically, and it is shown that when the wave-length considerably exceeds the dimensions of the focus " push " or " pull " waves are observed according as the origin is a source or sink. If the wave-length is comparable with the dimensions of the origin both varieties of waves are observable. Comparison with actual earthquakes leads to the inference that the dimensions of the seismic origins are comparable with the wave-length of the resultant waves. [See Abstract 2946 (1935).] C. A. S.

**595. Diurnal Periodicity of Felt Earthquakes. F. Kishinouye.** *Tokyo Univ. Earthquake Research Inst., Bull.* 14. *pp.* 604–609, *Dec.,* 1936. *In English.*—Earthquakes are more likely to be felt at night, probably owing to greater general stillness. That moderate earthquakes occur more frequently at night is not proved. C. A. S.

**596. African Rift Valley Earthquake of 1928, January 6. E. Tillotson.** *Roy. Astron. Soc., M.N., Geophys. Supplement,* 4. *pp.* 72–93, *Jan.,* 1937.—The Subukia Valley earthquake of 1928 January $6^{d}$ $19^{h}$ $31^{m}$ $58^{s}$ has been investigated in some detail by collecting the evidence of seismograms from all parts of the world, and corroborating this by the work of local surveyors. It had a surface focus at 0°·20 N., 36°·22 E. geographic latitude and longitude. Readings of the reflected and refracted pulses in addition to the straightforward $P$ and $S$ waves have been made, and these have been checked according to the nature of the wave and its angle of emergence. Both Love and Rayleigh waves have been shown to be present, which appears to indicate both initial $P$ and $S$ movement. The earthquake is peculiar in that the $S$–$P$ differences are greater than expected even with a surface focus, and the explanation is suggested that after the effect of the surface focus, *i.e.*, the longer transit in the upper layer and refraction at the base of this layer, is allowed for, the remainder may be found in the effective elastic constants of the rocks in the neighbourhood of the epicentre in what are usually termed the granitic, intermediate, and basaltic layers. AUTHOR.

**597. Royal Society Expedition to Montserrat, B.W.I. Preliminary Report on Seismic Observations. C. F. Powell.** *Roy. Soc., Proc.* 158*A*. *pp.* 479–494, *Jan.* 15, 1937.

*See also* Abstracts 507, 580, 581.

## TERRESTRIAL ELECTRICITY AND MAGNETISM.

**598. Field of Diurnal Variation of Terrestrial Magnetism. M. Hasegawa.** *Imp. Acad. Tokyo, Proc.* 12. *pp.* 221–228, *Oct.*, 1936. *In English.*—Observations of diurnal magnetic variation on Sept. 23, 24, 1933, and June 21, 23, 1934, were obtained from all accessible magnetic observatories. From these were calculated the diurnal variations at 11 h. (2 h. G.M.T.) along meridians 30° apart, over the earth. The results are given in world charts of the external and internal electric current systems prevailing on June 21 and 23, 1934. In the second part, charts of equipotential lines of magnetic variation are given from which the following conclusions are derived. The field of diurnal magnetic variation undergoes, even in the same season, a great change, accompanied by no apparent change in the measure of magnetic activity. This day-by-day change is so predominant that seasonal characteristics are almost masked. The centres of the principal minima of magnetic potential differ in latitude in the two cases investigated by about 20°. In one case, the principal minimum potential seems to have two centres. G. E. A.

*See also* Abstracts 579, 936, 937, 938.

## RADIOACTIVITY.

**599. Lead-Uranium Ratio of Henvey Cyrtolite. O. B. Muench.** *Am. Chem. Soc., J.* 58. *pp.* 2433–2434, *Dec.*, 1936.—As pointed out by Lane (*Am. Min.* 21. *p.* 374, 1936) the lead ratio is abnormally low and only about a sixth of that of the uraninite from the same mine. He gives a possible explanation of this. Practically the entire sample was used for the determinations described in this paper, leaving an insufficient amount for an atomic weight determination of the lead. The approximate age of this mineral in the absence of an atomic weight determination of the lead, is calculated from the analysis as 139 × $10^6$ years. The amount of Th is so small that no critical test of the two methods is indicated by the results. The percentage of S is higher in this cyrtolite than in the other cyrtolites which were analysed at the same time for S. AUTHOR.

**600. Introduction of Radioactive Halogens into Organic Molecules. N. Brejneva, S. Roginsky and A. Schilinsky.** *Acta Physicochimica,* 5. 4. *pp.* 549–574, 1936. *In German.*—Possible methods for the introduction of radioactive isotopes into complex molecules are investigated and an exchange procedure is developed for isotopic halogen atoms. In particular, the exchanges of $AlBr_3$ with a series of organic and nonorganic compounds are studied, and some regularities established for the velocities of these processes. The exchange of $AlBr_3$ with Cl and I derivatives is also investigated. The technique for the rapid introduction of radioactive Br into aliphatic halogen derivatives is worked out, and observations are described with respect to the exchange of $AlI_3$ with iodides. Very full experimental details are included together with comprehensive data. H. H. Ho.

**601. Quantitative Study of Pleochroic Haloes. Part III. G. H. Henderson, C. M. Mushkat and D. P. Crawford.** *Roy. Soc., Proc.* 158*A*. *pp.* 199–211, *Jan.* 1, 1937.—Pleochroic haloes due to the Th family are studied by means of the halo photometer. Five rings are found in the halo, which satisfactorily account for all the $\alpha$-particles of this family. The ranges are in good agreement with accepted values and the range found for Th, 2·53 cm. at 15° C. and 760 mm., furnishes valuable evidence as to the magnitude of this constant. A ring corresponding to $\alpha$-particles of very short range, 1·18 cm., and of undetermined origin, is found in these haloes. A full discussion is given of the accuracy of measurement. [For Parts I and II see Abstracts 3233 and 3234 (1934).] AUTHORS.

**602. Fermi's Theory of $\beta$-Decay. E. Gora.** *Indian Acad. Sci., Proc.* 4*A*. *pp.* 551–554, *Nov.*, 1936.—Planck's derivation of the formula for the number of oscillators per unit volume, together with the relation between the frequency and the natural line width, suggest that a factor of the order of magnitude $\alpha^{-3}$ may have to be introduced in Fermi's expression for the transition probability in the theory of $\beta$-decay. The new value for Fermi's constant $g$ is such that we obtain satisfactory agreement between Konopinski-Uhlenbeck's conclusions concerning the intensity distribution of $\beta$-ray spectra and the results of Heisenberg's and Iwanenko's application of Fermi's theory to the production of electron showers by cosmic rays and the interaction of heavy particles respectively. AUTHOR.

**603. Theory of β-Disintegration and Nuclear Forces. Part I. G. Wentzel.** *Zeits. f. Physik,* 104. 1–2. *pp.* 34–47, 1936.—A theory of β-disintegration and nuclear forces is introduced based on Fermi principles but which leads to proton-proton and neutron-neutron forces of the same order of magnitude as neutron-proton forces. F. C. C.

**604. β-Ray Spectra of Radium E and Radioactive Phosphorus. E. M. Lyman.** *Phys. Rev.* 51. *pp.* 1–7, *Jan.* 1, 1937.—The β-ray spectra of RaE and $P^{32}$ were obtained by means of a magnetic spectrometer of high resolution. The observed end points of the spectra of RaE and $P^{32}$ are at $5280 \pm 20$ $H\rho$ (1·15 eMV) and $7150 \pm 100$ $H\rho$ (1·69 eMV), respectively. The end points obtained by extrapolating the Konopinski-Uhlenbeck plots are in each case about 17 % greater than the observed ones, indicating that for some spectra these plots should not be used to determine the upper limits. AUTHOR.

**605. Absorption of γ-Rays. J. C. Jacobsen.** *Zeits. f. Physik,* 103. 11–12. *pp.* 747–755, 1936.—Using a null method in which two ionisation chambers are employed, the author determines the absorption coefficient for the γ-radiation of radiothorium when the absorption is due to pair formation and photo-absorption. Elements from H to Ag are dealt with. They are used in two ways, firstly in solution, and secondly in the metallic form. For pair formation the absorption coefficient per electron $\mu_e$ is theoretically proportional to the atomic number Z; this is experimentally verified and a value of $\mu_e/Z = 3{\cdot}8 \times 10^{-28}$ is obtained for a γ-radiation with an energy of $2{\cdot}6 \times 10^6$ V. This value of the absorption coefficient is in good agreement with the calculations of Bethe. The photo-absorption is vanishingly small in light elements. In the case of heavier elements however, satisfactory agreement is obtained with the theoretical calculations of Hulme and others. The accuracy of the experiments is limited by the inhomogeneity of the γ-radiation. G. O. B.

**606. Photographic Action of γ-Rays and their Absorption Coefficients. J. S. Rogers.** *Phys. Soc., Proc.* 49. *pp.* 1–11, *Jan.* 1, 1937.—The photographic action of γ-rays is intensified by using technical X-ray intensifying screens more than by using lead foil. These intensifying screens, however, intensify the longer wave-lengths more than the shorter. It has been found that the heterochromatic γ-ray spectrum from Ra (B + C) can be analysed into two apparently homogeneous components. Both components, however, appear to have an effective wave-length which is shorter the higher the atomic number of the absorbing material. These results can be explained, at least approximately, by a consideration of the absorption of the main lines in the γ-ray spectrum of Ra (B + C). This explanation suggests the presence in this spectrum of lines of moderate intensity of wave-length less than 5·6 X. [See Abstract 3806 (1932).] AUTHOR.

***607. Comparison of γ-Ray Intensities from Radium Preparations. J. A. C. Teegan.** *Roy. Dublin Soc., Proc.* 21. 42. *pp.* 449–452, *Dec.,* 1936.—A simple electrometer-valve amplifying system is described, suitable for comparing the ionisations produced by γ-radiation from various sources. By inserting a calibrated potentiometer into the grid-bias circuit, a more accurate " null " method of measurement can be used. Tests of the apparatus are described, in which various gases were used in the ionisation chamber. J. E. R.

*See also* Abstracts 412, 417, 420, 421, 841, 842, 843, 844.

# RADIATION.

## COLORIMETRY.

***608. Indicating Lantern Slide Colour Mixer. J. J. Heilemann.** *Am. Phys. Teacher*, 4. *p.* 211, *Dec.*, 1936.—This colour mixer for lecture-demonstration utilises an ordinary projection lantern and other readily available materials. The primary colours may be mixed in any proportions, and a roughly quantitative indication of these proportions is possible. AUTHOR.

**609. Colour of Wines. A. Boutaric, L. Ferré and Madeleine Roy.** *Comptes Rendus*, 203. *pp.* 1142–1144, *Nov.* 30, 1936.—Deals briefly with the results of a spectrophotometric examination of wines. The optical densities of a number of wines are given and all have their maximum density at 520m$\mu$. As the wines have different colours a further quantity is necessary to give a colour indication, this being obtained from the ratio of the optical densities at 480 and 640m$\mu$. R. C. F.

## ELECTRO-OPTICAL AND MAGNETO-OPTICAL EFFECTS.

**610. Paramagnetic Rotatory Power of Hydrated Ethyl Sulphate of Dysprosium, and Paramagnetic Saturation. J. Becquerel, W. J. de Haas and J. van den Handel.** *K. Onnes Lab., Leiden, Comm. No.* 244*a*. *Physica*, 3. *pp.* 1133–1142, *Dec.*, 1936. *In French.*—At the temperature of liquid He, the paramagnetic rotation $\rho_p$, in the direction of the optic axis, consists of two terms; one is a function of $H_a/T$, where $H_a$ is the éffective field. The other, a much smaller term, is independent of the temperature T, and is proportional to $H_a$. The law has the form: $\rho_p = A \tanh (\mu H_a/\kappa T) + BH_a$. The form of the first term shows that at sufficiently low temperatures there is only one energy level, doubly degenerated. The presence of a second term indicates that even in this simple case two distinct forms of paramagnetism exist simultaneously. For the first term the asymptote is practically reached in a field of the order 25000g. It is the first case in which total paramagnetic saturation has been attained. At temperatures of liquid $H_2$ and higher temperatures, several energy levels appear, and the above law is no longer followed. G. E. A.

**611. Magnetic Rotation and Magnetic Double Refraction of Benzene Derivatives, Pure and in Solution. J. Rabinovitch.** *Comptes Rendus*, 203. *pp.* 1249–1252, *Dec.* 7, 1936.—The substances studied were the three nitroanilines, paratoluidine and benzyl (all dissolved in acetone), metatoluidine, and orthotoluidine mixed with $CCl_4$. Verdet's constant is given for the Hg yellow and green lines and Cotton and Mouton's constant for the yellow lines. Ortho-and meta-nitroanilines show a much greater dispersion of magnetic rotation than the para derivative and this results in a breakdown, for the red end of the spectrum, of Perkin's rule that the ortho derivative has the greatest magnetic rotation. W. S. S.

## FLUORESCENCE AND PHOSPHORESCENCE.

## LUMINESCENCE AND AFTERGLOW.

**612. Decay of Fluorescence. F. Duschinsky.** *Acta Physica Polonica*, 4. 4. *pp.* 435–446, 1935. *In German.*—Szymanowski's method for the measurement of the decay of fluorescence is criticised in detail and the conditions under which it would give valid results are investigated. [See Abstract 3832 (1935)]. C. B. A.

**613. Quenching of Fluorescence and Photo-Sensitisation in Solutions. . E. W. Schpolsky and G. D. Sheremetiev.** *Acta Physico-chimica,* 5. 4. *pp.* 575–592, 1936. *In English.*—The quenching of the fluorescence of rhodamin G extra, eosin B extra, erythrosin, and chlorophyll in relation to the sensitised photo-oxidation of $Na_2SO_3$, and of eosin to Eder's eraction is studied. $O_2$ quenches only in the case of chlorophyll. The quenching produced by $Na_2SO_3$ decreases with increase in temperature and with decrease in the degree of association of the dye. $SO_4''$ produces the same effect as $SO_3''$. $(NH_4)_2C_2O_4$ produces no quenching of eosin fluorescence; $HgCl_2$ does. The curves of the intensity of the fluorescence and the rate of Eder's reaction against the concentration of $(NH_4)_2C_2O_4$ are parallel. Hence in neither case is there any connection between quenching of fluorescence and sensitisation of the photo-reaction which proceeds by absorbed energy which plays no part in fluorescence. H. G. C.

**614. Fluorescence of Pure Substances. E. Canals and P. Peyrot.** *Comptes Rendus,* 203. *pp.* 998–999, *Nov.* 16, 1936.—A continuation of previous work [see Abstract 4201 (1935)]. It was shown before that all the oxy-compounds were fluorescent. But among the hydrocarbons examined some were fluorescent and some not. The latter have been re-examined after extreme purification. It is found that they are not fluorescent. J. E.

**615. Influence of the Temperature of Uranium Solution upon the Fading Time of the Fluorescence. S. W. Cram.** *Zeits. f. Physik,* 103. 9–10. *pp.* 551–559, 1936.—The improved method of measurement of fluorescence of Szymanowski permits of the investigation of the influence of the temperature of U solutions on the time of falling-off of fluorescence. It appeared that in the water-alcohol solutions of feeble concentration ($10^{-4}$ gm./cm$^3$.) in the interval between 0° and 30° C. the fading-away falls off strongly with rise of temperature. A further rise of temperature, however, produces no marked change of the fading. If the U concentration increases the temperature effect becomes ever feebler till finally with a concentration of about $6 \times 10^{-3}$ gm./cm$^3$. it is smaller than error of observation. Similarly to the concentration acts also the viscosity of the means of solution. The measurements which were carried out with solutions of gradually increasing viscosity showed that the effect was always feebler till with a highly viscous solution it became incapable of observation. An attempt to bring these results of measurement into agreement with the Franck-Wawilow theory led to no satisfactory result. J. J. S.

**616. Excitation of Phosphors in the Neon Discharge. A. Rüttenauer.** *Zeits. f. techn. Physik,* 17. 11. *pp.* 384–387, 1936. *Phys. Zeits.* 37. *pp.* 810–812, *Dec.* 1, 1936.—Results for zinc sulphide and zinc silicate phosphors are discussed. W. R. A.

## INTERFERENCE, DIFFRACTION AND SCATTERING.

**617. Optical Investigation of Indian Oils. Part III. Intensity of Scattered Light. C. V. Jogarao.** *Indian Acad. Sci., Proc.* 4*A*. *pp.* 621–624, *Dec.,* 1936.—The intensity of the transversely scattered light (ether = 1; benzene = 3·2) in the case of five dust-free oils is measured by means of the rotating sector photometer. Using values of compressi-

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bility, refractive index and depolarisation available for olive and castor oils, the intensity of the scattered light is calculated. The calculated values agree with the experimental values. It is concluded that the light scattered by the oils is molecular in origin. [For Part II see Abstract 254 (1937).] AUTHOR.

**618. Phase Difference in Fraunhofer Diffraction Phenomena. Part II. J. Picht.** *Zeits. f. Instrumentenk.* 56. *pp.* 481–489, *Dec.*, 1936.—The formulæ obtained in the previous treatment [see Abstract 4649 (1936)] are now modified and discussed in more detail, with special reference to the work of Zernicke. C. B. A.

**619. Absorption and Scattering of Light in Hydrophobic Colloids. (Miss) B. Gribnau.** *Kolloid Zeits.* 77. *pp.* 289–294, *Nov.*, 1936.—The theory of scattering and absorption due to Mie, and applied by him to gold sols, is discussed, and the extension of the theory by Casperson to white sols. The extinction of metal sols is mainly due to " consumption " absorption (degradation of light energy to thermal energy of the particles) and scattering plays only a secondary part. In white sols the colour is dependent only on the scattering. The coloured non-metal sols are intermediate between the white and the metal sols. Details of the results are given for experiments on Se sols. A. C. M.

**620. Widening of Light Beams in Scattering Media (Plotnikow Effect). M. Katalinić.** *Kolloid Zeits.* 77. *pp.* 295–298, *Dec.*, 1936.—The author ascribes the effect observed in a photograph by Čoban [see Abstract 4966 (1935)], and ascribed by him to the Plotnikow effect, to halation. A. C. M.

**621. Absolute Measurement of Light Scattered by Liquid Benzene. P. Peyrot.** *Comptes Rendus,* 203. *pp.* 1512–1514, *Dec.* 28, 1936.—Photographic measurements of the intensity of light scattered from liquid benzene are described and the results compared with those for other compounds. It is concluded that the theoretical formula of Vessot-King is valid for acyclic but not for aromatic compounds. C. B. A.

***622. Grayson Micro-Ruling Machine. W. Stone.** *Journ. Sci. Instruments,* 14. *pp.* 8–14, *Jan.*, 1937.—The principles involved in the design of micro-ruling machines are stated and it is shown how these principles were applied by Grayson in the design and construction of the machine which he made and used in ruling test plates with as many as 120,000 lines to the inch. The machine is described in detail. [See also Abstract 596 (1934).] AUTHORS.

*See also* Abstracts 654, 803.

## PHOTOCHEMISTRY (INCLUDING PHOTOGRAPHY).

**623. Photodecomposition of Ammonia. H. J. Welge and A. O. Beckman.** *Am. Chem. Soc., J.* 58. *pp.* 2462–2467, *Dec.*, 1936.—The photochemical and Hg photosensitised decompositions of $NH_3$ are investigated in the region of very small amounts of decomposition. In contrast to the results obtained with large amounts of decomposition, namely, a quantum yield of 0·25 and gaseous products consisting of 75 % $H_2$ and 25 % $N_2$, with small amounts of decomposition the quantum yield approaches unity and the gaseous products approach pure $H_2$ in the case of the photochemical decomposition. For the photosensitised decomposition a quantum yield of 0·12 was obtained. AUTHORS.

**624. Free Propyl Radical. H. H. Glazebrook and T. G. Pearson.** *Chem. Soc., J. pp.* 1777–1779, *Dec.*, 1936.—On exposure to u.v. light, di*iso*propyl ketone yields free radicals which combine with Hg to give *n*-propylmercury. It appears that the radical first liberated is *iso*propyl, which subsequently tautomerises. The half-life periods of *n*-propyl from di-*n*-propyl ketone and of *iso*propyl from di*iso*propyl ketone have been compared under identical experimental conditions and found to be $4 \cdot 0$ and $4 \cdot 4 \times 10^{-3}$ sec., respectively. AUTHORS.

**625. Characteristic Curve of a Photographic Material. J. E. de Langhe.** *Physica*, 3. *pp*. 904–920, *Nov*., 1936. *In German*.—Continuing earlier work [see Abstract 3540 (1935)] the author deduces a general statistical theory for the form of the characteristic curves of a monodisperse single-grain layer of silver halide emulsion exposed to any monochromatic radiation, on the assumptions, (1) that "packets" of photolytic Ag atoms are formed on the grain surfaces, the number of Ag atoms per "packet" depending upon the size of the quantum concerned; (2) that these "packets" are distributed (at sensitivity centres) at random over the grain surface, but may re-aggregate themselves to form larger groups; (3) that a minimum number (3–4) of Ag atoms are necessary to form a development centre. The density (D), exposure (E) curve is found to have a point of inflection when the number of sensitivity centres ($k_1$) requiring for development only one such "packet" falls below a determinate value; for $\alpha$-rays and hard X-rays, therefore, there is no such point of inflection, the (D,E) curve having an initial region of maximum slope proportional to $k_1$, while for longer wave-lengths and/or very fine-grained emulsions there may even be a threshold value of E below which no density is developable. The $\gamma$ value, or maximum slope of the usual (D, log E) curve, can be dependent on wave-length only in so far as the number of sensitivity centres depends on wave-length; since, experimentally, the former dependence is not observed then the latter cannot exist. Explanations are also derived (1) of the growth to a maximum, during ripening, of the sensitivity and contrast of an emulsion and (2) of the Schwarzschild effect. L. V. C.

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**626. Tone Reproduction and Sensation of Contrast. F. F. Renwick.** *Phot. J.* 77. *pp*. 6–17, *Jan*., 1937. *Hurter and Driffield Memorial Lecture*.—It is not possible except in preparing transparencies to realise, with commercially available materials, the requirements of accepted tone-reproduction theory. In the interests of latitude of negative exposure, the characteristic curves (density *vs*. log exposure) of both negative and positive material should be linear; experimental printing papers approximately meeting this requirement have been produced. A distinction is drawn between subjective and objective contrast. The latter is usually expressed in terms of the slope of the D, logE curve; the author suggests an improved method of deriving the average slope of a non-linear characteristic. A statistical study of printing papers showing that, for a common maximum black, subjective contrast is a linear function of log (objective contrast) is used as the basis of a proposed range of printing papers varying from extremely soft to extremely hard contrast and the printing ranges of the corresponding negative materials are indicated. Reference is also made to (i) the effect of variations in the Fechner fraction upon the form of the ideal reproduction curve, (ii) the possibility of printing extremely thin negatives by reflected light, with much gain in print contrast, (iii) to the degrading effect on the negative of light scattered by multi-component lenses; (iv) to procedures such as that of Person for producing enhanced contrast effects in the highlight and shadow regions of a paper print. L. V. C.

**627. Influence of Bleach-Bath on Colour Obtained by Indirect Sulphide-Toning. H. Bäckström and A. Boström.** *Phot. J.* 76. *pp.* 607–612, *Dec.*, 1936.—Tests on a wide range of bromide, chlorobromide ("art" or "warm-tone") and chloride ("gaslight") papers of different makes, employing bleach baths varying independently in $K_3Fe(CN)_6$ and in KBr content, show (i) with bromide papers, there is a maximum warmth (yellowness) of tone at a small KBr content (about 0·2 %), $K_3Fe(CN)_6$ content being of little importance, (ii) with chloride papers the tone is yellowest at, in the limit, zero KBr content but that KBr concentrations above 1–1½ % show no tone variation; with these papers, also, a maximum warmth of tone is found at 2 % $K_3Fe(CN)_6$ concentration, (iii) with chlorobromide papers, the final tone is little affected by variations in either constituent. Replacement of KBr by KI produces great unexplained changes in the final tone, very yellow tones being obtained with high KI contents (> 5 %) regardless of $K_3Fe(CN)_6$ content. L. V. C.

**628. Photographic Plates Sensitised by Sodium Salicylate. Tien Kiu.** *Comptes Rendus*, 203. *pp.* 1144–1146, *Nov.* 30, 1936.—Gives results which show that treatment by salicylate solutions has the effect not only of increasing the sensitivity in the visible region but also of increasing the contrast, the increase in the sensitivity being greater the longer the wave-length. Further, from a comparison of the illuminations necessary to give a density of 2·5 with treated and untreated plates, it is found that there is a large increase in sensitivity, this being constant for one plate over quite a wide range of wave-lengths but increasing appreciably below 3,000 Å with another plate. These results show that an explanation considering fluorescence is not sufficient to take into account all the variations obtained. R. C. F.

**629. Ripening Condition and Regression Processes in Photographic Layers. Lüppo-Cramer.** *Kolloid Zeits.* 77. *pp.* 369–372, *Dec.*, 1936.—Briefly discusses the effects of the emulsion ripening conditions on regression processes in the light of previously published results of the present and other authors, it being concluded that with solarisation, the reduction of the developability of AgBr grains with long illumination depends on a destruction of the necessary contact, for development, between the Ag particles and the AgBr grain. R. C. F.

**630. Stability of Motion-Picture Films. J. R. Hill and C. G. Weber.** *Bureau of Standards, J. of Research*, 17. *pp.* 871–881, *Dec.*, 1936.—For some time past, many institutions—libraries in particular—have faced the problem of record storage in terms of space, cost, and stability. Among other subjects seriously considered with a view to a solution is the problem of photographically transferring records to a film base by what is commonly known as microphotography. Custodians of records have accumulated experience in this field, but most of them hesitate to adopt a definite policy until more is known about the stability of film bases. The National Archives is especially interested owing to the great volume of Government records under its jurisdiction, duplicates of which in many cases are not available. This interest was increased when the Division of Motion Pictures and Sound Recordings was set up and efforts were made to preserve such material. As a result of this interest the National Archives transferred money and personnel to the National

Bureau of Standards with the understanding that the study then in progress on cellulose acetate film should be broadened to cover also cellulose nitrate film. Under this arrangement the work has moved rapidly forward and with gratifying results. The National Archives acknowledges the co-operation of the National Bureau of Standards and other participants in this work for their helpful contributions in so far as it has been a beneficiary. AUTHORS.

***631. Rotating Drum Camera for Photographing Transient Phenomena. R. Lambert.** *Rev. Sci. Instruments,* 8. *pp.* 13–15, *Jan.,* 1937.—A rotating drum camera suitable for photographing transient voltages or currents with a kathode-ray oscillograph is described. Film speeds up to 750 in. per sec. have been employed. The times of exposure are controlled and related transient phenomena are synchronised by means of rotating switches. AUTHOR.

***632. High-Speed Photographic Measurements. H. E. Edgerton, J. K. Germeshausen and H. E. Grier.** *J. of Applied Physics,* 8. *pp.* 2–9, *Jan.,* 1937.—Several high-speed non-stroboscopic cameras are described and details are given of their operation and applications. The basic phenomena involved in taking such photographs with the light from electrical discharges are discussed at length. Stroboscopic types of apparatus are also discussed. Details are also given of the moving-optical-system type of camera. A. H.

*See also* Abstracts 471, 613, 661, 708, 709, 771, 772, 778.

## PHOTOMETRY.

**633. Problems of Modern Photometry. A. Dresler.** *V.D.I.* 80. *pp.* 1405–1408, *Nov.* 21, 1936.—The author discusses the physiological principles on which the concepts of light measurement are based and then goes on to deal with the difficulties of visual heterochromatic photometry which have become specially prominent with the introduction of gaseous discharge tubes. The possibilities of blocking-layer photo-cells for light measurement are examined. W. S. S.

**634. U.V. Radiation Measurements with the Blocking-Layer Cell. H. Krefft and F. Rössler.** *Zeits. f. techn. Physik,* 17. 11. *pp.* 479–481, 1936.—The Se blocking-layer cell possesses sensitiveness extending up to the short-wave ultra-violet. With suitable glass and liquid filters narrow regions between 2700 Å and about 4000 Å can be defined. By means of the combination of these filters with the cell there is formed a handy means for the estimation of technical sources of radiation. The structure and characteristics of the arrangement are described. J. J. S.

***635. Improvement of Hefner Lamp. E. Gehrcke, M. Goebert and C. Müller.** *Phys. Zeits.* 37. *pp.* 881–885, *Dec.* 15, 1936. *From the Reichsanstalt.*—An important disadvantage of the Hefner lamp is its unsteadiness which the authors show to be due to variations in the height of the flame. The concurrent variations of flame-height and candle-power have been studied photoelectrically. A great improvement can be effected by placing the lamp on a coarse-mesh iron gauze platform supported well above the table or bench. This platform also carries a metal cylinder, 55 cm. high and 32·5 cm. in dia. which surrounds the lamp and acts as a kind of wide chimney. The cylinder has holes at the side, with gauze attachments, to enable photometric observations to be made. Provision is also made for observing and adjusting the height of the flame. It is found that with this protecting device the flame becomes more slender, and pointed and is very much steadier. The candle-power is unchanged. J. W. T. W.

*See also* Abstracts 609, 672, 738.

## POLARISATION.

**636. Effect of Polarisation in a Quartz Spectrograph. G. Bolla.** *Zeits. f. Physik,* 103. 11–12. *pp.* 756–767, 1936.—In photographing a continuous H spectrum with a quartz spectrograph, using a polariser placed in front of the slit, the author obtained more or less complicated variations of the photographical density along the spectrogram. The results vary according to the construction of the spectrograph employed. Two Hilger instruments were used, an $E_1$ and an $E_2$. The results can be completely explained by considering the rotation of the plane of polarisation in the various lenses and prisms in the instruments, and reflection losses at the various planes (of the prisms and the photographic plate) met with by the incident radiation. G. O. B.

**637. Rotatory Power and Structure of Electrolytic Solutions. I. Peychès.** *Ann. de Physique,* 6. *pp.* 856–993, *Dec.,* 1936.—A detailed account is given of the methods of determining the specific rotation, $[\alpha]$, of the tartaric ion ($T = {}^{-}COO.(CHOH)_2.COO^{-}$) for concentrations $C = M/1000 - 2.5M$. The results are plotted against concentration for solutions of $M_2^{I}T$ and $M^{II}T$ ($M^{I}$ = Li, Na, K, Rb, Cs, $Tl^{I}$, $NH_4$, $NMe_4$, $NEt_4$, $NPr_4$ and $NH_3C_7H_7$; $M^{II}$ = Ca, Sr and Ba) in $H_2O$, MeOH, EtOH, PrOH, acetone and dioxane, without and with addition of other salts of the kations concerned (*e.g.* LiCl, NaCl, etc.). The empirical formula $[\alpha] = [\alpha]_0 + a\sqrt[3]{C} + b\sqrt[3]{C^2}$ connecting $[\alpha]$ and C is deduced, where $a$ and $b$ are constants, $b$ depending on the ionic radius. The hypothesis is put forward that $\Delta\alpha$ is a linear function of the ionisation potential [see Abstract 169 (1934)], whence values of the ionic radii are deduced that do not agree with those otherwise determined. The conductivity, u.v. absorption and Raman effect of many of the same solutions are next similarly, but with less detail, examined. An attempt is then made to interpret the results in the light of the Debye-Hückel theory of strong electrolytes, and it is shown that for this the theory requires modification so as to take into consideration the fact that the effective radii of different ions are different. Further the author's deductions seem to imply that the dielectric constant of the solvent in the immediate neighbourhood of the oriented molecules should be about thrice the ordinarily accepted value. He concludes that the phenomena at strong concentrations are extremely complex and interpretation can only be attempted when many other researches, and especially that regarding desolvation of the ions, furnish coordinated results. C. A. S.

**638. Solvent Action on Optical Rotatory Power. C. O. Beckmann and K. Cohen.** *J. Chem. Phys.* 4. *pp.* 784–804, *Dec.,* 1936.—A general theory of the optical rotatory power of liquids is developed. The method of C. G. Darwin, supplemented so that the fundamental quantities $s_{\alpha\beta\gamma}$ . . . which appear there are related to the properties of the molecules comprising the medium, is followed. The optical properties of a molecule are given by a set of tensors $\sigma'_{\alpha\beta\gamma}$ . . . The concept of deformation leads naturally to a simple relation between the $\sigma'_{\alpha\beta\gamma}$ . . .'s and the field acting on the molecule. The electrostatic field of the dipoles of the surrounding molecules is computed for the limiting cases of imperfect gases and dilute solutions, for molecules of simple geometrical configuration. This field is identified with the solvent field. For these idealised systems, the rotatory power of a molecule in various solvents is determined in terms of quantities characteristic of the solvents. The resulting equations are controlled by comparing with the behaviour of actual liquids. AUTHORS.

**639. Influence of Neutral Salts on the Optical Rotation of Gelatin. Part V. D. C. Carpenter and F. E. Lovelace.** *Am. Chem. Soc., J.* 58. *pp.* 2438–2441, *Dec.*, 1936.—The rotatory dispersion of gelatin is examined in various concentrations of NaBr at 0.5 and 40°, at five different wave-lengths in the visible spectrum. As was previously shown with NaI solutions, a single term Drude equation expressed the experimental results. An absorption band at 2200 Å. governed the dispersion. The rotatory dispersion constants of gelatin at 40° follow the linear equation $k_{40^\circ} = 44 \cdot 517 - 4 \cdot 415\, C_{\mathrm{NaBr}}$. The rotatory dispersion constants at 0·5° are found to be expressed by the sum of two equations: $C_{\mathrm{NaBr}} = (1/1 \cdot 33) \log \{a/(1-a)\} - \log (1/K)$ and the linear equation $K_{0 \cdot 5^\circ} = 46 \cdot 330 - 4 \cdot 8476 C_{\mathrm{NaBr}}$. It is concluded that the great change in rotation caused by halides at 0·5° is due to an association of the gelatin molecule. Based on the Lucas formulation, only two optically active species exist in gelatin solutions and gels. [For Part IV see Abstract 1172 (1936).] AUTHORS.

***640. Simple Azimuth and Phase Half-Shade of Variable Sensitivity. C. V. Kent.** *J.O.S.A.* 26. *pp.* 450–452, *Dec.*, 1936.—The azimuth half-shade component consists of two thin strips of glass mounted on and in front of the analyser with one long edge in contact and with their faces at an angle of 90°. The common contact edge is in the plane of polarisation of the analyser and is inclined at an angle with the direction of travel of the light. The phase half-shade component is an approximately quarter-wave mica plate placed in front of the glass strips, with its free edge bisecting the field of view at right angles to the common edge of the glass strips. The azimuth and phase sensitivity of the device are both varied equally by altering the angle of inclination of the common edge of the glass strips. The mode of action of the device is described. W. S. S.

*See also* Abstracts 657, 710, 714, 715.

## RADIATION, EMISSION.

**641. Tables of Planck's Radiation Formula. Part I. Z. Yamauti and M. Okamatu.** *Electrot. Laborat., Tokyo, Japan, Researches. No.* 395. [39 *pp.*], 1936. *English Abstract.*—Planck's formula is reduced to the form $E(\lambda T/c_2) = E_\lambda/E_m$, where $E_\lambda$ is the radiant energy for any wave-length $\lambda$ at temperature T° Abs., $E_m$ is the maximum energy at that temperature, and $c_2$ is a constant. Values of $\log_{10} E(\lambda T/c_2)$ to 5 significant figures are tabulated for values of $\log_{10}(\lambda T/c_2)$ ranging from $\bar{2} \cdot 400$ to $0 \cdot 400$, the intervals from $\bar{2} \cdot 400$ to $\bar{1} \cdot 400$ being 0·0001 and from $\bar{1} \cdot 400$ to $0 \cdot 400$ being 0·001. Another table gives the values of the function $\phi(\lambda T/c_2) = (1 - e^{-c_2/\lambda T})^{-1}$, which is the ratio of $E_\lambda$ by Planck's formula to $E_\lambda$ by Wien's formula, for values of $\log_{10} \lambda T/c_2$ from $\bar{2} \cdot 900$ to $0 \cdot 400$.

R. W. P.

**642. Report of the Work of the Bartol Research Foundation, 1935–1936. W. F. G. Swann.** *Frank. Inst., J.* 222. *pp.* 647–714, *Dec.*, 1936.

**643. Absolute Intensity of Cosmic Radiation at Sea-Level. J. Clay and H. F. Jongen.** *K. Akad. Amsterdam, Proc.* 39. 10. *pp.* 1171–1173, 1936.—The value of the ionisation by cosmic rays is measured in a vessel of 4·6 l. of cylindrical shape, with different electric fields up to 600

V./cm. In this way the saturation current could be found for each pressure. Between 23 and 38 atm. the wall ionisation is constant and from this it is derived that the ionisation in the gas at sea-level under 12 cm. Fe is 1,11 I per cm.$^3$/sec., in air of 1 atm. and for an open vessel 1·60 I per cm.$^3$/sec. The ionisation produced by electrons ejected from iron is 21 I per cm.$^2$ Fe. AUTHORS.

**644. Numerically Consistent Corpuscular Theory of Cosmic Rays. W.F.G.Swann.** *Phys. Rev.* 50. *pp.* 1103–1119, *Dec.* 15, 1936.—The writer generalises his former theory [see Abstract 4986 (1935)] according to which the primaries produce secondaries in numbers which increase with increase of primary energy. Taking the soft component first the theory is developed in detail and appropriate numerical values selected for the constants in the equations. The latitude effect obtained is too great, but the addition of a hard component showing no latitude effect brings about satisfactory agreement with experiment. It is shown that this hard component may just as well consist of electrical particles, operating mainly through secondaries, as of photons. It is shown that the theory fits in well with a number of the observed cosmic-ray phenomena. D. H. F.

**645. Cosmic Rays as Electrical Particles. A. H. Compton.** *Phys. Rev.* 50. *pp.* 1119–1130, *Dec.* 15, 1936.—Positive evidence that the primary cosmic rays consist of electrical particles is drawn from three types of experiments: namely, the latitude and directional asymmetry effects; certain coincidence experiments; and a directional asymmetry of cosmic rays ascribable to the motion of the earth with the rotation of Arc galaxy. It is shown how the evidence which has been adduced in favour of the hypothesis that the majority of the cosmic rays are primarily photons can be equally consistent with the hypothesis that the primaries are charged particles. D. H. F.

**646. Prolonged Record of Cosmic Radiation Intensity. W. Kolhörster.** *Zeits. f. techn. Physik*, 17. 11. *pp.* 371–373, 1936. *Phys. Zeits.* 37. *pp.* 797–799, *Dec.* 1, 1936.—Measurements were taken at Potsdam continuously from Jan., 1935, to Feb., 1936, by means of double coincidence counting. Averaging over three-monthly periods, a diurnal periodicity, both with central European time and sidereal time, is found, the amplitude of the latter being about half that of the former. Careful analysis of the results appears to confirm the reality of these periodicities. Differences between the results of the early part of 1935 and those of the corresponding period in 1936 are attributed to the influence of Nova Herculis. D. H. F.

***647. High Efficiency Light Sources. S. Dushman.** *J.O.S.A.* 27. *pp.* 1–24, Jan., 1937.—Summarises the present state of investigations in the field of light sources, dealing with the subject mainly from the physicists' point of view. The sections considered are luminous efficiency, incandescent solids as light sources, luminous efficiences of electric discharges in gases and vapours, origin of spectral lines and critical potentials, probability of excitation and ionisation, life of excited atoms and metastable states, fundamental electrical phenomena in a discharge, kathodic type of discharge, electron temperature, light output in kathodic discharge lamps, positive-column discharge lamps, light output in positive-column discharge, energy balance in a positive-column discharge, high pressure positive-column discharge lamps, and transformation of u.v. radiation into visible light. R. C. F.

*See also* Abstracts 648, 669, 670, 671, 672, 843, 844.

## RADIATION, GENERAL THEORY.

**648. New Derivation of the Wien Displacement Law. E. Lohr.** *Zeits. f. Physik*, 103. 7–8. *pp.* 454–459, 1936.—The Wien displacement law is deduced as far as possible by direct thermodynamical reasoning, although the generally used Rayleigh-Jeans electromagnetic model of free space radiation is assumed. H. J. H. S.

**649. Electronic Nature of Light. J. J. Placinteanu.** *Comptes Rendus*, 203. *pp.* 1343–1345, *Dec.* 14, 1936.—Developing his theory of photon formation [see Abstract 2180 (1936)] the author shows that the disappearance of mass in the formation of a photon by the association of an electron and positron can be explained by introducing in the Hamiltonian an interaction term, the mean value of which is the Hamilton-Jacobi action function. A similar term always appears in the wave equation of a system of variable masses. The quantisation of this supplementary term enables the probability to be expressed for the coalition of a variable mass electron-positron system to give a photon. N. M. B.

**650. Impossibility of a Neutrino Theory of Light. V. Fock.** *Comptes Rendus* (*Doklady*) *de l'Acad. des Sciences, U.S.S.R.* 4. 5. *pp.* 229–231, 1936. *In German.*—In attempting to disprove the existing neutrino theory of light, the author expresses the light field by a quantised wave function F, and the neutrino field by a quantised wave function $\psi$. For a neutrino theory of light a linear relation must exist between these functions. In the paper it is shown that no relation can exist, and that a neutrino theory of light is incompatible with the principle of superposition. The quantised operators used in the theory are shown not to obey the necessary interchange relations. Jordan found satisfactory interchange relations in his neutrino theory, but the errors in his method are apparently traceable to indeterminacies of the form $\infty - \infty$. G. O. B.

**651. Symmetry Theorem in the Positron Theory. W. H. Furry.** *Phys. Rev.* 51. *pp.* 125–129, *Jan.* 15, 1937.—In the positron theory considerable interest attaches to the consideration of processes in which the occurrence of electrons and positrons is transitory only, such as the scattering of light by a Coulomb field (Delbrück), and the scattering of light by light (Euler and Kockel). Calculations of such effects can frequently be simplified on account of cancellations brought about by the distribution's symmetry between electrons and positrons. An abstract proof is here presented for the theorem which predicts the appearance of such cancellations in the general case. Certain modifications are found to be required when interactions other than the usual electric forces are introduced. AUTHOR.

*See also* Abstract 495.

## RADIATION, MECHANICAL EFFECTS.

*See* Abstract 557.

## REFLECTION, REFRACTION AND DISPERSION.

**652. Curvature of the Field with Images for Cylindrical Lenses. H. Slevogt.** *Zeits. f. Instrumentenk.* 56. *pp.* 405–406, *Oct.*, 1936.—In a diagram are shown the curved images of a straight line obtained after refraction at the initial spherical surface, for the solid cylinder and for a sphere with glass of refractive index n = 1·5. The spherical aberration and errors arising from size of the aperture obtained in the two latter cases are compared. R. S. R.

***653. Continuously Variable Diaphragm for Spherical Aberration Studies. W. P. Gilbert.** *Am. Phys. Teacher,* 4. *p.* 212, *Dec.,* 1936. —A V-shaped slot cut in a piece of sheet metal and sliding in front of a straight slot cut in another piece of sheet metal provides two apertures whose distance apart is continuously variable. The lens is mounted immediately behind the diaphragm with the apertures symmetrically placed with respect to the central axis of the lens. AUTHOR.

**654. Refractive Indices by Interference Method and Microscope. N. Wedenejewa, S. Grum-Gržimajlo and A. Wolkoff.** *Acta Physicochimica,* 5. 3. *pp.* 391–404, 1936. *In German.*—The immersion method for refractive indices under the microscope loses its main advantage, simplicity, when the values to be measured exceed those for methylene iodide. Also the use of prism and goniometer is lengthy and the value obtained depends on the preparation used. A method is described to overcome the difficulties in which Lebedew's polarisation microscope is used as an interferometer. The method of setting up the interferometer is explained and also the principle underlying the method. Details are given of its application to the measurement of refractive indices for highly refracting mixtures of piperin with $AsI_3$ and $SbI_3$. R. S. R.

***655. Luminosity of Telescopic Instruments. V. Ronchi.** *Ricerca Scientifica,* 2. *pp.* 410–425, *Oct.,* 1936.—Experiments are described showing that the field luminosity L in a telescopic instrument directed at a luminous surface satisfies the following laws ; (1) for a fixed magnification L is proportional to $r^{2/z}$ where $r$ is the radius of the exit pupil and $(z\text{-}1)$ is inversely proportional to the magnification, (2) for a fixed exit pupil L is a linear function of the magnification, (3) for a given entrance pupil L is approximately independent of magnification. The importance of these laws in the design of instruments and their bearing on the visual response of the eye are indicated. W. S. S.

***656. Analactic Point for a Telescope with Internal Focusing Lens. A. Haerpfer.** *Zeits. f. Instrumentenk.* 56. *pp.* 425–427, *Oct.,* 1936. —In commenting on Schulz's statement that the analactic point must be always independent of the measurement between the main lens and the outer condensing lens in the interior of the telescope, it is shown that in practical applications of telescopes the necessary assumption regarding the position of this point between the lenses is made. Results are tabulated showing the errors obtained with four telescopic systems when working on these lines. R. S. R.

***657. Compensated Microscope Illuminator for Polarised Light. L. Capdecomme.** *Comptes Rendus,* 203. *pp.* 994–996, *Nov.* 16, 1936.— Further describes a " compensated illuminator " used in the measurement of reflecting powers with the microscope. [See Abstract 4687 (1936).] W. S. S.

**658. Method for Increasing Frontal Distance of a Microscope Objective. G. Deflandre.** *Comptes Rendus,* 203. *pp.* 1242–1244, *Dec.* 7, 1936.—The frontal distance of a microscope objective can be increased by placing below it a divergent achromatic lens of suitable focal length, without seriously diminishing the numerical aperture. C. B. A.

**659. Strengths and Separations in a Triplet System. H. Werner.** *Zeits. f. Instrumentenk.* 56. *pp.* 490–495, *Dec.,* 1936.—An investigation of the possibility that the calculations of strengths and separations of the components of a triplet are vitiated if the dispersions are previously specified. C. B. A.

**660. Afocal Systems. H. Schulz.** *Zeits. f. Instrumentenk.* 57. *pp.* 14–17, *Jan.*, 1937.—A general treatment of triplet systems is developed for technical use. C. B. A.

**661. Optics and the Textile Industry. E. R. Schwarz.** *J.O.S.A.* 27. *pp.* 44–50, *Jan.*, 1937.—A general review of the application of optical methods for textile research and investigation. The history is traced of microscopical measurement and the applications of polarised light, X-ray analysis, high-speed photography, fluorescence and colorimetry are briefly noted. S. G. B.

*See also* Abstract 763.

## SPECTROSCOPY.

**662. Spectra of Discharge in Air of High-Tension Magnetos J. Jaffray.** *Comptes Rendus,* 203. *pp.* 1347–1349, *Dec.* 14, 1936.—The visible and u.v. spectra were investigated. At the positive electrode line spectra of air and the elements occurring in the electrode were observed together with the second positive spectrum of N and the $\gamma$-spectrum of NO. At the negative pole in addition to the line spectra, the second positive and the negative spectrum of N were found as well as the $\gamma$ spectrum of NO. The effect of the various electrical factors of the circuit were studied and that of a large series resistance was found to be very marked. F. S.

**663. Spectra of Elements Ti to Co Similar to Mg I: Ti XI, V XII, Cr XIII, Mn XIV, Fe XV and Co XVI. B. Edlén.** *Zeits. f. Physik,* 103. 7–8. *pp.* 536–541, 1936.—In the region 126 to 47 Å, lines in the vacuum spark spectra of Ti, V, Cr, Mn, Fe and Co are identified as combinations in the spectra similar to Mg I, and the corresponding term systems are calculated. In addition, a doublet combination is indicated in those spectra of the same elements which correspond to Al I. C. B. A.

**664. Absorption Spectra of Salts of Ytterbium in Crystals and Solutions Compared with Those of Cerium. S. Freed and R. J. Mesirow.** *J. Chem. Phys.* 5. *pp.* 22–25, *Jan.* 1, 1937.—Absorption spectra of Yb salts resemble those of Ce very closely, especially in diffuseness. This is in marked contrast with sharp spectra of other rare earths. Resemblance was anticipated on supposition that the 13 electrons in the 4f shell of $Yb^{+++}$, one short of the maximum that the shell can hold, would give rise to but one term $^2F$, the same term as the one electron of $Ce^{+++}$ gives rise to. Thus activations are impossible when the 13 electrons remain in the 4f shell. This prohibition derives from the Pauli exclusion principle as it is applied in gases, but the lattice may modify application of this principle. It is likely that activated states of ions in crystals would respond to any change in application of the principle the lattice might impose. The spectra show that the principle holds for these ions in crystals in the same way as in gases. Confirmation is obtained that sharp spectra of other rare earths consist of " forbidden transitions " arising from a change in coupling among electrons of the 4f shell. A. H.

**665. Line Absorption of $Gd^{+++}$ in Crystals. G. C. Nutting and F. H. Spedding.** *J. Chem. Phys.* 5. *pp.* 33–45, *Jan.*, 1937.—The dependence on crystal symmetry and chemical composition of the energy levels in the solid is investigated by photographing the absorption spectrum of a number of Gd salts at temperatures 20°–300° K. The spectra are largely independent of the negative radical and of water of crystallisation but vary with the lattice symmetry as it is indicated by the crystallographic symmetry. Some of the organic salts give weak diffuse lines even at 20° K. Selective reflection is observed, that of the ethylsulphate giving lines at 20° K. less than 1 Å wide. The nature of the excited states is discussed. H. G. C.

**666. Spectrum of Trebly-Ionised Lead. M. F. Crawford, A. B. McLay and A. M. Crooker.** *Roy. Soc., Proc.* 158*A*. *pp.* 455–463, *Jan.* 15, 1937.—The spectrum of Pb IV has been photographed in the region from 400 to 9,000 Å. An analysis of the data has permitted the establishment of the terms from the one-electron configurations 6*s*, 7*s*, 8*s*, 6*p*, 7*p*, 6*d*, 7*d*, and 5*f*, which have been tentatively identified by other workers. In addition to these terms, we have found the 5*g* $^2$G and three $^2$H terms, the two terms from the inverted doublet $5d^9 6s^2\ ^2D$ and 22 of the 23 levels predicted for the $5d^9 6s6p$ configuration. The ionisation limit of 314,350 cm.$^{+11}$ corresponding to an ionisation potential of 42·11 V, was obtained by assuming the sequence *nh* $^2$H to be hydrogenic. The analysis is in agreement with the doublet laws, the excitation data, and the observed intensities. Hyperfine structure, due to the relative displacement of the terms of the lead isotopes $Pb^{206}$ and $Pb^{208}$, is resolved in 8 lines. These lines are all classified as transitions between terms arising from configurations involving a different number of 6*s* electrons. The observed shifts may be explained consistently by assigning to a term a displacement of 0·5 cm.$^{-1}$ for each 6*s* electron present, with the levels of the lighter isotope more stable than those of the heavier isotope. This explanation is consistent with Breit's theory of isotope shifts for the heavy elements and with the shifts observed in these spectra by other investigators. AUTHORS.

**667. Spectra of H.F. Discharges in Mercury Vapour. Part II. Comparison of Electrodeless with External Electrode Excitation. Part III. Modification Due to Wave-Length. J. K. Robertson and R. H. Hay.** *Canad. J. of Research*, 14. *Sect.A*. *pp.* 201–208, *Nov.*, 1936.—H.f. discharges in mercury vapour are excited by valve oscillators, and a comparison is made of spectra obtained by the use of a purely electrodeless method with those excited by external electrodes. Temperatures range from 100° to over 250° C., and the use of four wave-lengths of approximate values 5, 35, 75, and 200 m. make it possible at the same time to examine possible changes in the spectrum arising from changing frequencies. It is found that, with the exception of the highest frequency, external electrode excitation is more effective for the emission of arc and of spark lines, whereas diffuse bands and regions of continuous spectra can be separated from lines at higher pressures somewhat better by electrodeless excitation. Evidence is given that the discharge obtained at a frequency of 60 megacycles differs from that obtained at the lower frequencies. At a low vapour pressure a discharge, which is characterised by great brilliance and the absence of spark lines, is obtained with the highest frequency. There is little to choose between the two types of excitation. An explanation is suggested for the difference due to frequency. [For Part I see Abstract 590 (1933).] AUTHORS.

**668. Electron Concentration and Spectral-Intensity Distribution in a Cæsium Discharge. F. L. Mohler.** *Bureau of Standards, J. of Research*, 17. *pp.* 849–857, *Dec.*, 1936.—The theoretical relation between the transition probabilities for line emission in a given series and the probability of recombination into the final state of the series is derived from the postulate that the line intensity approaches the continuous intensity at the limit in thermal equilibrium. The measured values of A for the subordinate series of Cs lead to a value $1 \cdot 7 \times 10^{-21}$ cm$^2$. for the effective cross-section for recombination of a 0·3-volt electron into the 6P limit. Measurementments of recombination intensity and electron concentration have led to an identical value at low pressures, but the value apparently increased with pressure. It is concluded that probe measurements are systematically low at higher pressures and the intensity of the continuous spectrum is used as a basis for computing the true values of electron concentration $N_e$. It has been shown that at pressures above 60 $\mu$ all the higher series lines have the same reversal temperature. One can define a temperature, $T_s$, by a given value of $N_e$ in Saha's equation and the values so derived are equal to the reversal temperatures of the higher series lines. $T_s$ is always less than the electron temperature but the two approach each other with increasing pressure. AUTHORS.

**669. Spectral Energy Distribution and Luminous Efficiency of the Mercury High-Pressure Discharge. H. Krefft, K. Larché and F. Rössler.** *Zeits. f. techn. Physik,* 17. 11. *pp.* 374–377, 1936. *Phys. Zeits.* 37. *pp.* 800–803, *Dec.,* 1936.—Measurements were made of the luminous efficiency and spectral energy distribution of a Hg vapour discharge at pressures ranging from 1 to 30 atm. and for alternating currents from 1 to 8 A. The luminous efficiency was found to increase with gas pressure, reaching, for example, 70 to 80 lumens per watt at a pressure of 15 atm. and a current of 2 A. The rate of increase with pressure of the emission of the green line exceeds that of the yellow line. This is the opposite to what occurs in the pressure range up to 1 atm. The spectral energy distribution varies as the pressure increases in such a way that the intensity in the medium and long-wave u.v. decreases compared with the intensity in the visible region. The background of continuous spectrum increases with pressure. Self-absorption in the discharge column has a great effect on the spectral energy distribution. W. S. S.

***670. Brightness of the Mercury Discharge at High Pressures. R. Rompe and W. Thouret.** *Zeits. f. techn. Physik,* 17. 11. *pp.* 377–380, 1936. *Phys. Zeits.* 37. *pp.* 803–806, *Dec.* 1, 1936.—The authors describe a super-high pressure Hg discharge lamp differing considerably from the water-cooled capillary tube lamps of Bol, Elenbaas and de Groot. The lamp consists of a thick-walled quartz tube of about 3 cm. dia., enclosing two oxide-coated electrodes separated by about 5 mm. The discharge does not fill the tube and resembles that of the free burning arc. The Hg pressure equals 50 atmos. Consuming 650 W the lamp gives a horizontal candle-power of 5000 Hefner candles and has a brightness of 50,000 c./cm$^2$. The rest of the paper gives the results of measurements of brightness and other characteristics of a lamp of this type as functions of the pressure in the tube and the current. It is found that at a given pressure, the brightness increases linearly with the current and an explanation of this relation is advanced. W. S. S.

***671. Production of Higher Intensity of the Hydrogen Continuum by Glowing Kathode Tube. G. Jacobi.** *Zeits. f. techn. Physik,* 17. 11. *pp.* 382–384, 1936. *Phys. Zeits.* 37. *pp.* 808–810, *Dec.* 1, 1936.—A $H_2$-filled discharge tube with a glowing kathode, suitable for a light source of u.v. continuum, is described. W. R. A.

**672. Luminous Efficiency of the Positive Column of a Discharge in Sodium Vapour. B. Klarfeld and I. Taraskov.** *Techn. Phys., U.S.S.R.* 3. 10. *pp.* 881–892, 1936. *In English.*—The portion of the total energy in the positive column which is transformed into the energy of radiation of the yellow lines of sodium has been measured in the presence of various quantities of the rare gases A, Ne and He and at various sodium vapour pressures. At the same time the potential gradient and mean brightness were determined. AUTHORS.

**673. Pressure Broadening of the Potassium Resonance Lines by Argon and Nitrogen. G. F. Hull, Jr.** *Phys. Rev.* 50. *pp.* 1148–1150, *Dec.* 15, 1936.—Broadening of the K resonance lines in absorption by A and $N_2$ pressures from 1 to 40 atm. has been observed. Half-widths and shifts of the lines, when plotted against "relative density," yield curves that are straight lines up to about relative density 14, indicating that in this pressure region Lorentz type of broadening predominates. At about relative density 14, the curves depart from linearity. The results are in accord with theory, and partly in agreement with previous work. Theoretical contours for pressure broadened spectral lines have been fitted to those of experiment. Agreement is quite satisfactory, considering the approximations made in evaluating the theoretical curves. Three independent methods of calculation yield for the constant *b* (measure of van der Waals forces) the values $24(10)^{-32}$ and $18(10)^{-32}$ cm$^6$. sec.$^{-1}$ for A and $N_2$ respectively. AUTHOR.

**674. Pressure Broadening of Spectral Lines and van der Waals Forces. Parts I and II. H. Kuhn.** *Roy. Soc., Proc.* 158*A*. *pp.* 212–241, *Jan.* 1, 1937.—The continuous spectrum which forms the wing of a pressure broadened spectral line is produced by transits of atoms at distances within the range of the van der Waals forces (optical impacts). Within certain limiting conditions, the intensity distribution is very nearly identical with the occurrence distribution of the perturbed eigenfrequencies of single transits. It is therefore able to yield quantitative results on the van der Waals forces. In Part I the absorption coefficient in the wings of the Hg line 2537 Å broadened by A is measured at different pressures of A and Hg by means of photographic photometry. Its proportionality to the densities of Hg and A proves that it is produced by single transits. The discussion of the results leads to the conclusion of a considerable splitting of the excited state into two components, due to orientation of the J-vector against the axis of the collision pair. Between $\Delta\nu = 25$ and $\Delta\nu = 250$ cm$^{-1}$., the measured absorption coefficients are proportional to $\Delta\nu^{-3/2}$ as predicted by theory. This proves the validity of the $C/r^6$ potential law of the polarisation forces for internuclear distances between $3\cdot4$ and $4\cdot8 \times 10^{-8}$ cm. The constant C for the component $\Omega = 0$ of the excited state is found to be $C_0 = 2\cdot6 \times 10^{-32}$. In Part II the broadening of the absorption line 2536·5 Å of Hg vapour under the influence of its own pressure is measured. The distribution of the absorption coefficient in the long wave-length wing of the line agrees with the theoretically predicted $\Delta\nu^{-3/2}$ law, thus confirming the exponent $p = 6$ in the potential law $V \sim r^{-p}$ of the van der Waals forces. $p = 5$ or $p = 7$ would give less good agreement, any other integral value of $p$ striking disagreement with the measurements. Former measurements of the temperature coefficients of the continuous absorption are discussed. The total absorption in the discrete band system 2540 Å is measured. It yields an absolute value of the concentration of $Hg_2$ molecules. It can be used for calculating the heat of dissociation of the $Hg_2$ molecule by means of the Gibson and Heitler formula. The resulting value of 2·1 cal. is shown to be an upper limit, whereas the former thermal measurements ($\approx$ 1·5 cal.) are lower limits.

AUTHOR.

**675. Quadrupole Moment and Magnetic Moment of $^{69}_{31}$Ga and $^{71}_{31}$Ga. H. Schüler and H. Korsching.** *Zeits. f. Physik*, 103. 7–8. *pp.* 434–442, 1936.—From the hyperfine structure of the $4s5s\ ^3S_1 - 4s5p\ ^3P_{0,1,2}$ triplet of the Ga II spectrum the quadrupole moment of $^{69}$Ga is determined to be $q = +1 \times 10^{-24}$ and that of $^{71}$Ga is found to lie in the region $-0{\cdot}5 \times 10^{-24}$ to $+0{\cdot}5 \times 10^{-24}$. The magnetic moments found from Ga II are in good agreement with those found from Ga I = $\mu_{69} = +2{\cdot}0$ and $\mu_{71} = +2{\cdot}5$ nuclear magnetons. The ratio $\mu_{71}/\mu_{69}$ is given as 1·269. Small isotope displacements are found in the lines λ6456 and λ6419 of a magnitude $\Delta\nu$ 7 to $12 \times 10^{-3}$ cm$^{-1}$. and the centre of gravity of $^{69}$Ga is displaced towards the red. A table is given of all the quadrupole moments hitherto determined with the corresponding mechanical and magnetic moments.

J. E. K.

**676. Second Isotope of Cassiopeium and Magnetic Moment and Quadrupole Moment of the $^{175}_{71}$Cp Nucleus. H. Gollnow.** *Zeits. f. Physik*, 103. 7–8. *pp.* 443–453, 1936.—Hyperfine structure investigation of CpI lines leads to the discovery of a hitherto unknown isotope (173 or 177) the relative abundance and nuclear spin of which are found to be about 1·5 % and I = 7/2 (perhaps 9/2) respectively. The magnetic moment $\mu$ and the quadrupole moment $q$ are calculated from the hyperfine structure of CpI and CpII lines, more exactly than previously, to be $\mu = +2{\cdot}6$ nuclear magnetons and $q = +5{\cdot}9 \times 10^{-24}$ cm$^2$.

J. E. K.

**677. Nuclear Spin and Magnetic Moment of $Li^6$. J. H. Manley and S. Millman.** *Phys. Rev.* 51. *pp.* 19–21, *Jan.* 1, 1937.—The spin of the $Li^6$ nucleus and the hyperfine structure separation of the $^2S_{\frac{1}{2}}$ normal state have been measured by the atomic beam method of zero moments. The evaluation of the contribution of $Li^7$ to the intensity in the neighbourhood of the $Li^6$ zero moment peak was made by an extension of the method of analysis previously used in determining the spin of $K^{41}$ and $Rb^{87}$. The spin of $Li^6$ was found to be 2/2 and the hyperfine structure separation $0{\cdot}0077 \pm 0{\cdot}0001$ cm$^{-1}$. on the basis of the value of Fox and Rabi for $Li^7$. The ratio of the magnetic moments of the isotopes is $\mu_6/\mu_7 = 0{\cdot}258 \pm 0{\cdot}5$ %. From the value calculated by Breit and Doerman for $Li^7$, the moment of $Li^6$ is 0·85 nuclear magneton.

AUTHORS.

**678. Fine Structure in the Arc Spectrum of Platinum. S. Tolansky and E. Lee.** *Roy. Soc., Proc.* 158*A*. *pp.* 110–127, *Jan.* 1, 1937.—Lines of the Pt I spectrum in the region λλ6800–4320 are excited in a water-cooled hollow kathode and examined for fine structure with a silvered Fabry-Perot interferometer. 36 lines are studied. The isotopes observed in Pt are 198, 196, 195, 194, the abundance ratios being approximately 1 : 4 : 4 : 5. The 195 isotope has a nuclear spin of $\frac{1}{2}$ which is the value shown by a very large number of nuclei with an odd nuclear neutron. A fine structure analysis is carried out for 195, interval factors being calculated in a large number of terms. It is shown that the $5d^8$ and $5d^9$ electron groups have an appreciable coupling with the nucleus, from which it is concluded that in a heavy atom $5d_{3/2}$ electrons exhibit a certain degree of penetration. All the terms observed exhibit even isotope displacement, some of which attain the large value of 200 cm$^{-1}$. $\times 10^{-3}$ per isotope. In all the isotope displacements the lighter isotope, 194, lies deepest, and it is shown that the centre of gravity of the 195 pattern is not half-way between the isotope lines 194, 196, but lies nearer to 194. The value of the even isotope displacement in a term appears to be determined by the degree of penetration exhibited by any penetrating electrons in the term electron configuration. In a $6s^2$ electron group the two $6s$ electrons do not compensate but are additive in producing isotope displacement. The displacements are not a function of J, differing thus from the magnetic splitting in the odd isotope, which depends upon J. AUTHORS.

**679. Hyperfine Structure and Zeeman Effect of Resonance Lines of Silver. D. A. Jackson and H. Kuhn.** *Roy. Soc., Proc.* 158*A*. *pp*. 372–383, *Jan*. 15, 1937.—The hyperfine structure of the Ag resonance lines is investigated by the method of absorption in an atomic beam. Each line possesses four components; for the line $5^2S_{1/2} - 5^2P_{3/2}$, 3281 Å, the positions are 0·000, − 0·013, − 0·052 and − 0·077 $cm^{-1}$.; for $5^2S_{1/2}$–$5^2P_{1/2}$, 3383 Å, they are 0·000, − 0·013, − 0·058 and − 0·084. In both lines the short wave-length components are nearly equal in intensity and much stronger than the two of longer wave-length, which are also of nearly equal intensity; photometric measurements show that the intensity of the strong to the weak lines is 3 : 1. The component at − 0·013 is rather stronger than that at 0·000 $cm^{-1}$., that at − 0·052 is rather stronger than that at − 0·077 $cm^{-1}$. The two inner components are ascribed to Ag 107, the two outer to Ag 109. The calculated nuclear magnetic moments are − 0·10 nuclear magneton for Ag 107 and − 0·19 for Ag 109. Observations of the Zeeman effect show a spin of 1/2 for each isotope and corroborate the above assignment of the lines to the two isotopes. A. H.

**680. Hyperfine Structure of Rubidium Resonance Lines. H. Kopfermann and H. Krüger.** *Zeits. f. Physik*, 103. 7–8. *pp*. 485–490, 1936.—A hollow kathode cooled in liquid air was used as source, being entirely free from self-reversal. A Fabry-Perot etalon and 3-prism spectrograph were used to determine the hyperfine structure. The component separation of splitting of the $5\ ^2S_{1/2}$ level was measured as $\Delta\nu = 0{\cdot}228$ $cm^{-1}$. for Rb 87 and $\Delta\nu = 0{\cdot}101$ $cm^{-1}$. for Rb 85. The ratio of magnetic nuclear moments $\mu_{87} : \mu_{85}$ has the value 2·03; $\mu_{87} = 2{\cdot}8$ KM.; $\mu_{85} = 1{\cdot}4$ KM. F. S.

**681. Calculation of Atomic Energy Levels. Part IV. T. Yamanouchi.** *Phys. Math. Soc. Japan, Proc.* 18. *pp*. 623–640, *Nov*., 1936. *In English*.—Dirac's methods are applied to many of the problems considered in earlier parts of this work [see Abstract 1660 (1936)], and many of the formulæ are obtained in more compact forms and in more direct ways. A. H.

**682. Helium I Like Spectra. H. A. Robinson.** *Phys. Rev*. 51. *pp*. 14–18, *Jan*. 1, 1937.—New measurements of the $1s^2\ ^1S_0 - 1s{\cdot}np\ ^1P_1$ series of the He I isoelectronic sequence for Be III, B IV and C V together with previously published data on He I, Li II, N VI and O VII are critically examined and values for the $1s^2\ ^1S_0$ terms for these spectra obtained. A slightly modified Hylleraas type extrapolation formula is used to calculate these same values. When relativity, spin, mass and mass polarisation corrections are applied the agreement between observed and calculated values is very good for the heavier elements. A small discrepancy appears in the case of Li II. AUTHOR.

**683. Band Spectrum of the Ionised Mercury Deuterides. S. Mrozowski.** *Acta Physica Polonica*, 4. 4. *pp*. 405–418, 1935. *In German*.—Referring to his earlier paper [see Abstract 2741 (1936)] the author describes further experiments with the same source of light on the short-wave u.v. $HgH^+$ and $HgD^+$ band spectra. It was found that the source of light employed gave the $HgH^+$ spectrum much more intensely than those used by Jezewski and Hori. The $D_2$ used was got from 99·2 % $D_2O$ by means of Norling's apparatus and the source of light was the Hg-arc lamp previously used. A long list is given of the bands with their wave-lengths and frequencies. J. J. S.

**684. Band Spectrum of Bismuth Deuteride. A. Heimer.** *Zeits. f. Physik*, 103. 9–10. *pp.* 621–626, 1936.—The band spectrum of BiD is obtained and the system $^1\Sigma^*-^1\Sigma$ is analysed, the heat of dissociation and isotope effects are discussed. [See Abstract 3505 (1935).] W. R. A.

**685. Spectrum of Calcium Oxide. P. H. Brodersen.** *Zeits. f. Physik*, 104. 1–2. *pp.* 135–156, 1936.—The band spectrum of CaO has been photographed under high dispersion (2mm./Å) using a hollow kathode as source. With the help of previous values obtained with an arc between rods of Ca metal, the bands have been arranged in a series of systems and an attempt made to set out the electron-term-schemes. A table of term constants is given and the relation of the dissociation products to the fixed terms of the bound atom discussed. F. S.

**686. Absorption Spectra of Acyclic Saturated Alcohols between 6000 and 9500 Å. P. Barchewitz.** *Comptes Rendus*, 203. *pp.* 1244–1247, *Dec.* 7, 1936.—Measurements of absorption spectra of alcohols and some halides lead to the following conclusions :—(i) The bands of straight-chain compounds are usually double, whilst those with branched chains give single bands with slightly lower frequencies. The intensities depend on the length of the C chain. (ii) The OH band at 7420 Å—with the exception of methyl alcohol—has a constant wave-length in the homologous series of straight-chain compounds but branching of the chain leads to displacement. The frequency increases with temperature, particularly near the critical point. C. B. A.

**687. Infra-Red Absorption of Alcohol-Acetone Mixtures. W. Gordy.** *Phys. Rev.* 50. *pp.* 1151–1153, *Dec.* 15, 1936.—Several mixtures of methyl alcohol and acetone are studied in the region 2·5 μ to 8·5 μ. The acetone is found to shift the OH vibrational band of alcohol to the shorter wave-lengths and to increase appreciably its intensity ; the effects of the alcohol on acetone are to increase the intensity of the vibrational band of the CO group and to shift it to the longer wave-lengths. No other bands are measurably affected. The results indicate association of the alcohol and acetone through interaction of the OH and CO groups. The possibility of the formation of proton bonds is suggested. AUTHOR.

**688. Infra-Red Absorption Spectra of Dioxane-Water Mixtures. W. Gordy.** *J. Chem. Phys.* 4. *pp.* 769–771, *Dec.*, 1936.—The absorption spectra of various dioxane-water mixtures are studied in the region 2·5 μ to 6·5 μ. Dioxane is found to produce marked changes in the water spectrum. The observed variations are more pronounced for low water concentrations. Association of the water and dioxane molecules is suggested as a possible explanation of the observed effects. [See Abstract 5019 (1935).] AUTHOR.

**689. Analysis of Isotopic Mixtures of Deuteromethanes and Ethanes by Infra-Red Absorption Spectra. W. S. Benedict, K. Morikawa, R. B. Barnes and H. S. Taylor.** *J. Chem. Phys.* 5. *pp.* 1–9, *Jan.*, 1937.—The infra-red absorption spectra of a large number of D, containing methane samples, and a few of ethane, are studied with a rock-salt spectrometer. All the observable fundamental frequencies of each individual methane isotope are identified, and from the relative intensity of absorption at various characteristic wave-lengths the composition of any mixture of these isotopes may be determined. The infra-red spectra of deuteroethanes including $C_2D_6$ are observed. AUTHORS.

**690. Infra-Red Absorption Spectrum of Hydrogen Chloride in Solution. W. West and R. T. Edwards.** *J. Chem. Phys.* 5. *pp.* 14–22, *Jan.*, 1937.—Near infra-red absorption bands of HCl in non-ionising solvents, about 3·5 μ and 1·8 μ, have following characteristics: no rotational structure; two components of unequal intensities; absorption region displaced towards lower frequencies compared with gas. Displacement is independent of concentration up to mole fraction 0·1, but increases with diminishing temperature in certain solvents. The interval between components varies directly with solvent dielectric constant. In solution, relative displacement of more intense component from origin of gas band is approximately the same for 3·5 μ and 1·8 μ bands, as is also the interval between components. A simple relation exists between frequency displacement from gas origin and solvent dielectric constant. The more intense component, whose relative shift from gas origin is the same as the corresponding shift in the Raman spectrum, is interpretated as originating in the internuclear vibration, and it is suggested that the other component represents a combination between such vibrational transitions and some slow inter-molecular vibration between HCl and solvent molecules. A. H.

**691. Absorption Spectrum of Nitroglycerin. K. Masaki.** *Chem. Soc., Japan, Bull.* 11. *pp.* 712–715, *Nov.*, 1936.—Spectra were obtained with thicknesses and concentrations varying from 50 c.c. of the pure liquid to 1 mm. of *N*/1000 alcoholic solution. The spectrum is compared with those of a number of nitro-compounds and it is deduced that the two diffuse bands are due to the $NO_2$ group. H. G. C.

**692. Absorption Spectrum of Cæsium. Ny Tsi-Zé and Weng Wen-Po.** *Comptes Rendus*, 203. *pp.* 860–862, *Nov.* 3, 1936.—The same apparatus was used as in the earlier case [see Abstract 3197 (1936).] All rays and bands of Cs were observed and new ones found when the temperature was raised to 500° C., and these were classified in series. The series E and G were identified with combinations of the series 6S−mD and 6S−mS. Rays and bands near to the principal series were grouped for 6S−10P and 6S−12P and tabulated. This classification of heads of bands suggests their molecular origin. At 450° C. between 6S−8P and 6S−9P and between 6S−12P and 6S−13 P two new systems of bands were found, and the wave-lengths of some main bands are given. R. S. R.

**693. Spectroscopic Study of the Constitution of Sulphur Vapour. B. Rosen and Nina Morguleff.** *Comptes Rendus*, 203. *pp.* 1349–1351, *Dec.* 14, 1936.—A band system C has been attributed to the molecule $S_x$ where *x* lies between 8 and 2. To investigate this more closely the absorption has been observed at 500° C. and 1000° C. and at various pressures. The ratio of intensities is independent of pressure at 1000° C. but not at 500° C., and it is concluded that there is a continuous background at the latter temperature which disappears at 1000° C. One band system between 3600 and 6000 Å is attributed to $S_2$, while the continuous background is attributed to $S_8$ in agreement with the calculations of Preuner, Schupp and Brockmüller. F. S.

**694. Third Absorption Bands of Coordination Compounds. Part I. R. Tsuchida and S. Kashimoto.** *Chem. Soc., Japan, Bull.* 11. *pp.* 785–790, *Dec.*, 1936. *In English.*—In order to verify the postulate that the third band is due to a pair or pairs of negative radicals co-ordinated in transpositions to each other, extinction coefficients of $[Co(No_2)_6]Na_3$, $[CO(NH_3)_4Cl\ NO_2]Cl$, $[Co(NH_3)_4(NO_2)_{2(6)}^{(1)}]Cl$, $[Co(NH_3)_2(NO_2)_4]NH_4$, etc. were measured. Aqueous solutions of $[CO(NO_2)_6]Na_3$ and $[Co(NH_3)_4Cl\ NO_2]Cl$ were proved to have the third bands as will be predicted from the postulate. Regularities among the frequencies of the first, the second, and the third band were pointed out, viz. for the Co complex salts, which show the third band, $\nu_3-\nu_2$ and $\nu_2-\nu_1$ are $33 \times 10^{13}$ and $18 \times 10^{13}$, whereas for the pentammine and the tetrammine cobaltic salts, $\nu_2-\nu_1$ is $27 \times 10^{13}$ and $24 \sim 26 \times 10^{13}$ respectively. AUTHORS.

**695. Ultra-Violet Absorption Spectra of Simple Hydrocarbons. Part I. n-Heptene-3 and Tetramethylethylene. Emma P. Carr and Margery K. Walker.** *J. Chem. Phys.* 4. *pp.* 751–755, *Dec.*, 1936.—The u.v. absorption spectra of *n*-heptene-3 and tetramethylethylene were measured in liquid and hexane solution phase, between 4000 Å and 2100 Å and in vapour phase between 2300 Å and 1500 Å. Curves showing the logarithm of the molecular extinction coefficient as a function of the wave number are given for the measurements in the quartz region and tables giving the regions of absorption together with the wave-lengths of the centres of bands for the measurements with the fluorite vacuum spectrograph. Comparison with earlier work shows the progressive shift toward the visible of the absorption bands in the Schumann region as the H atoms of ethylene are replaced by alkyl groups, and the parallelism between the spectra of different hydrocarbons having the same configuration with respect to the double bond. [See following Abstract.] AUTHORS.

**696. Ultra-Violet Absorption Spectra of Simple Hydrocarbons. Part II. In Liquid and Solution Phase. Emma P. Carr and Gertrude F. Walter.** *J. Chem. Phys.* 4. *pp.* 756–760, *Dec.*, 1936.—Molecular extinction coefficients for 12 olefine hydrocarbons have been determined between $\lambda = 3300$ Å and 2100 Å and are given in the form of curves showing the logarithm of the extinction coefficient as a function of the wave number. The beginning of absorption, as measured by $\log\epsilon = -2{\cdot}0$, is quite characteristic of the number of alkyl groups bound to the C atoms of the double bond and is only very slightly affected by the nature of the alkyl group. [See preceding and following Abstracts.] AUTHORS.

**697. Ultra-Violet Absorption Spectra of Simple Hydrocarbons. Part III. In Vapour Phase in the Schumann Region. Emma P. Carr and Hildegard Stücklen.** *J. Chem. Phys.* 4. *pp.* 760–768, *Dec.*, 1936.—The absorption spectra of 14 ethylenic hydrocarbons are recorded between 2300 and 1500 Å. The wave number of the first absorption band is influenced by the number but not by the nature of the alkyl groups bound to the C atoms of the C = C bond. The band is tentatively assigned, as by Snow and Allsopp [see Abstract 876 (1934)], to the transition $^1A_1 \rightarrow {}^1B_1$. Overlapping with another group of bands of higher intensity occurs, and a third group is also found in some of the spectra. The bands are broad and diffuse, but some separations, possibly related to the 1350 cm.$^{-1}$ frequency of $C_2H_4$, are recognised. [See preceding Abstract.] C. B. A.

**698. Kinetics of OH Radicals as Determined by their Absorption Spectrum. Part II. Electric Discharge through $H_2O_2$. A. A. Frost and O. Oldenberg.** *J. Chem. Phys.* 4. *pp.* 781–784, *Dec.*, 1936.—

In order to study the kinetics of OH radicals in $H_2O_2$ the concentration of OH as a function of time is measured by the decay of the intensity of the OH absorption bands after interrupting an electric discharge through $H_2O_2$. For each snapshot a new supply of $H_2O_2$ is introduced into the absorption tube and partly decomposed into OH + OH by an electric discharge of brief duration. OH radicals disappear in $H_2O_2$ much more rapidly than in $H_2O$. This indicates a bimolecular reaction OH + $H_2O_2$. The emission spectrum of OH shows abnormal rotation of OH even more strongly when excited in $H_2O_2$ than in $H_2O$, the rotation being determined not by the temperature but by the simultaneous dissociation and excitation producing the OH radicals observed. [For Part I see Abstract 5149 (1936).]

AUTHORS.

**699. Absorption Spectra of Samarium Tungstate and Molybdate at Low Temperatures. S. Freed and E. L. Haenisch.** *J. Chem. Phys.* 5. *pp.* 26–29, *Jan.*, 1937.—As a preliminary to a study of the relation between the fluorescence and the absorption spectra of crystals, we photographed the absorption spectra of single crystals of $Sm_2(WO_4)_3$ and of $Sm_2(MoO_4)_3$ at 78° K, 113° K, 169° K, and 298° K. Evidence was found that an activated state 76 $cm.^{-1}$ from the basic state exists in the tungstate. The general patterns of the spectra of the tungstate and of the molybdate are not the same, indicating that the crystals do not belong to the same space group, an inference likely to be made from crystallographic data. There is also evidence for a dissociation, perhaps an incipient dissociation in the lattice, as if the tungstate and especially the molybdate dissociated into the basic and acidic oxides within the single crystal.

AUTHORS.

**700. Effect of Alkyl Groups on Anthraquinone and Fluorescein Dyes. R. M. Harris, G. J. Marriott and J. C. Smith.** *Chem. Soc., J. pp.* 1838–1844, *Dec.*, 1936.—The effects of increasing length of the alkyl chain in 1-amino-2-alkylanthraquinones are: (1) A lowering of the melting point; (2) a progressive shift and broadening of the absorption band; (3) a progressive increase in the extinction coefficient throughout the absorption band; (4) a rapid increase in general absorption up to the butyl, and very slow further increase to the dodecyl, homologue. On the blue dyes (1-amino-4-anilino-2-alkylanthraquinone derivatives), the effects of increasing alkyl are: (1) A progressive shift in the absorption band; (2) no appreciable increase in the extinction coefficients or the general absorption; (3) an increased rate of dyeing; (4) an increase in covering power on wool, probably constant after the heptyl homologue. Alkyl groups in fluorescein dyes cause an increased absorption of red light and an increase of covering power. For the less soluble dyes aqueous-alcoholic dye-baths are essential for even dyeing. AUTHORS.

**701. Absorption Spectra of Triiodides. C. B. Allsopp.** *Roy. Soc., Proc.* 158*A*. *pp.* 167–181, *Jan.* 1, 1937.—Twin bands, which are now observed in the absorption spectra of alcoholic solutions of $AsI_3$, $SbI_3$, $BiI_3$, and $SnCH_3I_3$, are very similar to those found in the spectra of solutions of $CHI_3$. The influence of solvents on the absorption spectra of the triiodides and of $CHI_3$ is investigated and discussed; and it is shown that the twin bands in these cases can have the same origin as those found in the spectra of the iodide ion, of absorbed $I_2$ molecules, of the polyhalides of the alkalis, and of a number of iodine derivatives of quadrivalent and hexavalent Te, namely in the simultaneous production during irradiation of I atoms in the normal and in the excited, metastable state. AUTHOR.

**702. Vibrational Analysis of Emission Bands of Germanous Oxide. R. W. Shaw.** *Phys. Rev.* 51. *pp.* 12–14, *Jan.* 1, 1937.—21 bands degraded to the red and associated with GeO have been observed in the region λ2500 to λ2900. The wave numbers of the band heads are expressed by the equation:

$$\nu=37763\cdot7+649\cdot4\,(v'+\tfrac{1}{2})-3\cdot81\,(v'+\tfrac{1}{2})^2-985\cdot0\,(v''+\tfrac{1}{2})+4\cdot36\,(v''+\tfrac{1}{2})^2.$$

Attention is called to the regular variation of the dissociation energies for the normal states of the monoxides and monosulphides of the fourth periodic column. It is shown that the electronic transition $^1\Pi\rightarrow{}^1\Sigma$ for the GeO system seems to agree best with the available evidence. It is found that the quantity $\omega_e''r_e^2\cdot10^{-16}$ cm. is very nearly constant for the fourth column monoxides. From this it is concluded that 1·65 ± 0·06 Å is a good value of $r_e$ for GeO. The dense structure due to overlapping bands and isotope effect makes rotational analysis extremely difficult. AUTHOR.

**703. Anomalous Intensity Variation in the Band System $2p^1\Sigma_u\rightarrow 1s^1\Sigma_g(v'=3\rightarrow v''=0$ to $11)$ of the Hydrogen Molecule, HD. O. Bewersdorff.** *Zeits. f. Physik*, 103. 9–10. *pp.* 598–620, 1936.—Beutler and Mie observed that for HD the band system specified above exhibits a periodic variation of intensity with increase of $v''$, the bands for $v''=3,6,9$, being extremely faint. The author determines the potential curves for the two electronic terms in question using the formula of Hylleraas. The vibration eigenfunctions are then calculated by Kramers' method and from these the transition probabilities are derived. The calculated band intensities correctly reproduce the observed periodic variation with the vibration quantum number $v''$. It is suggested that a similar intensity anomaly in the resonance band system of the iodine molecule $I_2$ may be explained on similar lines. W. S. S.

**704. Recombination of Diatomic Molecules under Irradiation. R. Rompe.** *Zeits. f. techn. Physik*, 17. 11. *pp.* 381–382, 1936. *Phys. Zeits.* 37. *pp.* 807–808, *Dec.* 1, 1936.—An estimation of the frequency of recombination under irradiation gives $10^{-4}$ to $10^{-3}$ indicating individual collision between an excited and an unexcited atom. W. R. A.

**705. Calculation of the Fundamental Vibration Frequencies of $C_2H_4$, $C_2D_4$, and $C_2H_2D_2$. C. Manneback and A. Verleysen.** *Ann. Soc. Sci. de Bruxelles*, 56. *pp.* 349–372, *Dec.* 23, 1936.—In addition to valency and deformation forces two terms representing interaction of the two $CH_2$ and CC are necessary. Other coupling terms seem to be small. From the potential function calculated for $C_2H_4$ the vibration frequencies of $C_2D_4$ and the three isomers $C_2H_2D_2$ are calculated by a general method. The Raman and infra-red frequencies are deduced and regularities in the different spectra discussed. H. G. C.

**706. Energy of Metastable Nitrogen Molecules. H. Hamada.** *Phil. Mag.* 23. *pp.* 25–33, *Jan.*, 1937.—From the data of previous investigations it follows that the energy of the metastable molecules in active $N_2$ as well as in the $N_2$ excited by a weak electric current, may be either 6·14 volts or about 7·4 volts according to different viewpoints, and the present work was undertaken to obtain more precise knowledge regarding the energy of these metastable molecules. Accordingly the band spectrum of metastable $N_2$ has been examined and its energy estimated from the metallic spectra excited by the metastable $N_2$ molecules in the afterglow of the positive column. All the observed results are accounted for without assuming the concentrated existence of non-vibrating molecules. An examination of the distribution of intensity in the band systems of other

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molecules excited by active $N_2$ and comparison with that in cases of excitation by electron collision or by white light was not sufficiently decisive to enable an application of the Franck-Condon principle.

H. H. Ho.

**707. Vibration Spectra and Molecular Structure. Part I. General Remarks and a Study of the Spectrum of the OH Group. R. B. Barnes, L. G. Bonner and E. U. Condon.** *J. Chem. Phys.* **4.** *pp.* 772–778, *Dec.*, 1936.—A brief survey is given of the ideas underlying the interpretation of molecular vibration spectra in connection with molecular structure problems. This is followed by a discussion of the reasons for the appearance or nonappearance in the spectrum of the characteristic frequency at 3400 $cm^{-1}$. for various molecules containing the OH group. In certain alcohols and gylcols this frequency has not been reported in the Raman effect, but it is concluded that this must be due to experimental difficulties. In the carboxylic acids, on the other hand, as well as in certain aromatic compounds containing OH, the characteristic frequency is definitely absent from both the Raman and infra-red spectra, and the rôle of the H bond in association and chelation is discussed in connection with these cases. AUTHORS.

**708. Predissociation of Polyatomic Molecules. F. Duschinsky.** *Acta Physicochimica,* 5. 5. *pp.* 651–654, 1936. *In German.*—The type of predissociation in polyatomic molecules which depends (according to Polanyi and Wigner) on superposition of several normal vibrations excited simultaneously is discussed and compared with normal predissociation in diatomic molecules. C. B. A.

**709. Dichroism of Dye-Stuff Molecules. P. Pringsheim.** *Acta Physica Polonica,* 4. 4. *pp.* 331–339, 1935. *In German.*—The polarisation of the fluorescence of dye-stuff molecules when adsorbed on cellophane is compared with that of the free molecules in glycerin solution. The results are discussed in the light of Jabłoński's theory, and it is concluded that the emission may be satisfactorily explained by attributing it to an oscillator which must be almost linear. C. B. A.

**710. Negative Polarisation of Fluorescence Bands of Adsorbed Dye-Stuffs at Low Temperatures. P. Pringsheim and H. Vogels.** *Acta Physica Polonica,* 4. 4. *pp.* 341–344, 1935. *In German.*—Experiments are described which establish the existence of negative polarisation (*i.e.*, secondary vector perpendicular to the primary vector) in some fluorescence bands of some dye-stuffs both adsorbed on cellophane and when embedded in isotropic media (*e.g.*, glycerin). C. B. A.

**711. Fluorescence Spectra of Biacenaphtylidene Fluorocyclene, and Fluorene Solid and in Solution. B. Twarowska.** *Acta Physica Polonica,* 4. 4. *pp.* 355–367, 1935. *In French.*—The spectra of the crystalline powders and of the solutions in *o*-xylene at 16° and −180° C. are studied. They are sharper and the intensity maximum is of shorter wave-length at the lower temperature. For biacene and fluorocyclene the solution gives sharper bands of shorter wave-length than the solid. In the case of fluorene the solid gives sharper bands which occupy the same region as those of the solution. Only fluorene shows phosphorescence, that of the solution embracing that of the solid and extending beyond it. The variations in the spectra are explained by the perturbing effect of neighbouring molecules which is dependent on their complexity and mobility. [See following Abstract.] H. G. C.

**712. Fluorescence Spectra of Organic Dyes in the Solid State. B. Twarowska.** *Acta Physica Polonica,* 4. 4. *pp.* 369–370, 1935. *In French.*—Further dyes, rhodulin yellow, benzoflavin, and trypaflavin (see preceding Abstract) have been examined in the solid and in solution. In each case the intensity maximum for the solid is to long wave-length of that for the solution. None of the dyes showed any phosphorescence. H. G. C.

**713. Absorption and Emission of Light by Molecules Embedded in Solid Media in Orderly Orientation. A. Jabłoński.** *Acta Physica Polonica,* 4. 4. *pp.* 371–387, 1935. *In German.*—The following properties of a completely ordered molecular array, embedded in a solid medium, are predicted: (i) The dichroism is independent of frequency. (ii) The depolarisation of a given luminescence band is independent of the type of excitation. (iii) This independence may be taken as evidence of the orderly orientation of the molecules. (iv) For those bands which are a direct reversal of the absorption bands in which the excitation occurs, the depolarisation of the photo-luminescence, $I_s/I_\pi$, is equal to the ratio of the absorption coefficients $\mu_s/\mu_\pi$ for the light vibrations in the corresponding directions. A molecular array which is partially orientated and partially isotropic is also considered, and the corresponding properties are derived. C. B. A.

**714. Anisotropy of the "Equivalent Oscillators" in Molecules from Measurements of the Polarisation of Photo-luminescence. A. Jabłoński.** *Acta Physica Polonica,* 4. 4. *pp.* 389–394, 1935. *In German.*—On the basis of the view that each electron transition in a molecule may be replaced by an equivalent spacially-anisotropic oscillator, the possibility of determining the corresponding polarisabilities from measurements of depolarisation of the photoluminescence of isotropic solutions is discussed. C. B. A.

**715. Decay of Polarised Fluorescence. Part II. A. Jabłoński.** *Zeits. f. Physik,* 103. 7–8. *pp.* 526–535, 1936.—In continuation of previous work [see Abstract 2966 (1935)] the investigation of the laws of decay of polarised fluorescence is now extended from molecules with only spherical symmetry to those with non-spherical symmetry, attention being paid to various new depolarising mechanisms. The new equations are similar to those already obtained. The fluorescence component which is not affected by Brownian rotations is also uninfluenced by other factors and decays exponentially. The form of the formulæ of Perrin and of Soleillet for the degree of polarisation of the fluorescence is not altered by the new considerations. C. B. A.

**716. Absorption and Luminescence Spectra of Organic Dyes. A. Wrzesińska.** *Acta Physica Polonica,* 4. 4. *pp.* 475–488, 1935. *In German.*—Absorption and fluorescence spectra are recorded for trypaflavine, benzoflavine, rheonine A, enchrysine 3 R, fluorescein, uranine, rhodamine, eosin, isoquinoline red, and rhoduline yellow 6 G, the solvent being aqueous glycerine. In each case, the fluorescence at −180° C. is displaced towards higher frequencies from that at 20° C., and the phosphorescence spectrum, in general, falls at lower frequencies than the fluorescence spectrum. C. B. A.

**717. Fluctuation Bands in the Fluorescence Spectrum of Cd Vapour. A. Kotecki.** *Acta Physica Polonica,* 4. 4. *pp.* 489–495, 1935. *In German.*—The wave-lengths of the intensity maxima of 33 fluctuation bands between 4300 and 3630 Å in the fluorescence spectrum of Cd vapour are recorded. These wave-lengths are independent of the method of excitation and of the temperature or pressure of the vapour. Neither the continuous fluorescence nor the fluctuation spectrum is polarised. C. B. A.

**718. Zeeman Effect. E. Sevin.** *Comptes Rendus,* **203.** *pp.* **1147–1149,** *Nov.* **30, 1936.**—A purely mathematical treatment which shows that when the effect of spin is taken into consideration Schrödinger's equation gives two particular solutions, one of which corresponds to the abnormal Zeeman effect and the other to the normal effect. A. H.

**719. Zeeman Effect in the Alkalies According to the Dirac Equation. R. Schlatterer.** *Ann. d. Physik,* **27. 7.** *pp.* **643–663,** *Dec.,* **1936.**—The Zeeman effect is investigated on the basis of the Dirac wave equation for the case of atoms with a single external electron. An approximation method is employed which is different from that used by Pauli. Fine structure and magnetic resolution are treated simultaneously as perturbations. The presence of a magnetic field then leads to very little complexity in the calculations. C. B. A.

**720. Raman Spectra of Light and Heavy Phosphine and Arsine. M. de Hemptinne and J. M. Delfosse.** *Ann. Soc. Sci. de Bruxelles,* **56.** *pp.* **373–383,** *Dec.* **23, 1936.**—The Raman spectra of $PH_3$, $PD_3$, $AsH_3$, and $AsD_3$ are measured and calculated. The values obtained on the assumption of harmonic forces are poor and 3rd and 4th order terms are allowed for by comparison with the diatomic molecule and by assuming that deformation and valence vibrations can be completely separated. The anharmonicity correction allows by means of the Birge-Sponer formula of the calculation of the dissociation energy and the calculated result is of the right order. The fourth Raman frequency, found only for $ND_3$ for which the agreement is good, is calculated. H. G. C.

**721. Raman Band of Water in Sulphate Solutions. F. Cennamo.** *N. Cimento,* **13.** *pp.* **304–309,** *July,* **1936.**—An account is given of the results obtained on the modifications that the Raman band of water at about 3500 $cm.^{-1}$ undergoes from the presence of certain sulphates in solution. J. J. S.

**722. Raman Spectrum of Methyl Deutero-Alcohol. S. Mizushima, Y. Morino and G. Okamoto.** *Chem. Soc. Japan, Bull.* **11.** *pp.* **698–699,** *Oct.,* **1936.** *In German.*—Examination of the Raman spectra of $CH_3OH$ and $CH_3OD$ has been made. Isotopic shifts in frequencies of $CH_3OH$ are found for the band **3270 – 3480** $cm.^{-1}$ and for the line 1107 $cm.^{-1}$, the latter is attributed to a deformation vibration of the OH group. [See Abstract 4598 (1935).] W. R. A.

**723. Raman Effect of Furane Derivatives. K. Han.** *Chem. Soc., Japan, Bull.* **11.** *pp.* **701–711,** *Nov.,* **1936.**—The Raman spectra of the following substances have been measured: α-furfuryl methyl ether, α-furfuryl ethyl ether, α-furfuryl-acetone, α-furyl-ethylene, α-furyl cyanide, 2,5-dimethyl-furane, 2-methyl-furyl cyanide-(5) and ethyl 2-methyl-furoate-(3). The characteristic frequencies of the α-furfuryl-radical are confirmed. The difference of the Raman spectra of the mono- and di-derivatives of furane is established. The constitutive influences exerted on the Raman frequencies in the region between $\Delta\nu$ 1400 and 1600 $cm.^{-1}$ are observed. The Raman lines at 1642 and 1292 $cm.^{-1}$ in α-furyl-ethylene are associated with the structure of R-CH : $CH_2$, and those at 183, 570, and 2233 $cm.^{-1}$ in α-furyl cyanide with the structure of R-C ≡ N, when R is taken as furyl radical. AUTHOR.

**724. Raman Effect in Ammoniacal Solution. M. W. Wolkenstein.** *Acta Physicochimica*, 5. 5. *pp.* 627–644, 1936. *In German.*—The Raman scattering was investigated in Diver's fluid ($NH_4NO_3$, $2NH_3$) in $2NH_4CNS$, $5NH_3$, and in a mixture of these two ($3NH_4$ CNS, 1 $NH_4NO_3$) and in a saturated aqueous solution of $Ag(NH_3)_2Cl$. Six to eight Raman lines were found for each substance. The presence of interaction between the substance dissolved and the $NH_3$ is shown, and of a strong electrolytic dissociation of $HNO_3$ in $NH_3$. The non-appearance of lines attributable to the $NH_4$-ion is explained as due to the formation instead of $H(NH_3)n$ ions. On the basis of symmetry arguments the differences are explained between the Raman spectra of $NH_3$ in the gaseous, liquid, aqueous solution and complex-ion states. A. C. M.

**725. Intensity and Depolarisation of Raman Lines of Mixtures of Sulphuric and Nitric Acids. J. Chédin.** *Comptes Rendus*, 203. *pp.* 1509–1511, *Dec.* 28, 1936.—Continuing previous work [see Abstract 2235 (1936)] measurements of the intensity of the Raman line $\Delta\nu =$ 1400 $cm.^{-1}$ excited by Hg 4358 are used to determine the concentrations of $N_2O_5$ present in a range of mixtures of $HNO_3$ and $H_2SO_4$ containing small percentages of $H_2O$. It is noted that the degree of depolarisation of this line remains constant throughout. L. A. W.

**726. Raman Effect of Organic Sulphur Compounds. L. Médard and F. Déguillon.** *Comptes Rendus*, 203. *pp.* 1518–1521, *Dec.* 28, 1936.—The Raman spectra are reported for $(CH_3)_2S$, $(CH_3)_2S_2$, thiophenol, and for the methylsulphate and ethylsulphate ions, ($SO_4CH_3^-$ and $SO_4C_2H_5^-$). A. C. M.

**727. Raman Spectra of Simple Molecules in Solution. W. West and P. Arthur.** *J. Chem. Phys.* 5. *pp.* 10–13, *Jan.*, 1937.—Raman spectra of HCl, HBr, $SO_2$ and $NH_3$ in non-ionising solvents indicate vibrational frequencies in solute molecules of lower value than in corresponding gaseous states, the relative diminution amounting, in the dissolved hydrogen halides, to 3 % of the gas frequencies. The frequency shift is smaller for the two polyatomic molecules. There is a definite relation between relative frequency displacement and dielectric constant of solvent for dissolved HCl and HBr molecules. $\Delta\nu/\nu$ increases with solvent dielectric constant to a limiting value of 0·03. A similar trend is shown in $SO_2$; for $NH_3$ other factors than the solvent dielectric constant are effective in determining frequency displacement. Concentrated solutions of HCl and HBr in several ionising solvents have no features in their Raman spectra which can be identified as vibrations in HCl or HBr molecules. The bearing of these results on the dissociation process of HCl in solvents is discussed. A. H.

**728. Raman Spectrum of Decahydronaphthalene. S. M. Mitra.** *Zeits. f. Physik*, 103. 7–8. *pp.* 542–545, 1936.—The Raman effect in decahydronaphthalene is investigated with special reference to faint lines. 52 lines are recorded. The results are compared with those for cyclohexane and naphthalene. C. B. A.

**729. Raman Effect of Dibasic Acids in Crystalline State. B. Anand.** *Indian Acad. Sci., Proc.* 4*A*. *pp.* 603–609, *Nov.*, 1936.—Oxalic, malonic and succinic acids are studied in powder form. A pyrex tube Hg arc was used, bent so that it illuminated three sides of a cubic cell containing the powdered crystals. The possible modes of vibration of the molecules corresponding to the observed Raman frequencies are discussed.

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Frequencies 1660 and 1450 cm.$^{-1}$ are ascribed to $\mathrm{C=O}$ and $\mathrm{H{-}\overset{|}{\underset{|}{C}}{-}H}$ bindings respectively, and those between 1200 and 1000 cm.$^{-1}$ to $\mathrm{H{-}\overset{\overset{C}{|}}{C}{-}H}$, while lower frequencies correspond to the vibrations of the two main groups of atoms of the various molecules. A. C. M.

**730. Raman Spectra of Glasses. R. Langenberg.** *Ann. d. Physik*, 28. 1. *pp.* 104–113, *Jan.*, 1937.—Raman spectra are recorded for $SiO_2$, molten $B_2O_3$ and 24 glasses of different compositions. In the spectra of the glasses the following approximate frequencies are observed and ascribed: $SiO_4$, 500, 625, 800 and 1000–1140 cm.$^{-1}$; $BO_3$, 700, 915 and 1445 cm.$^{-1}$. Molten $B_2O_3$ also gave 803 and 1261 cm.$^{-1}$. The presence of Pb, Ba and alkali metals apparently makes no contribution to the Raman spectra of the glasses. L. A. W.

***731. Spectrograph with Strong Illumination. H. Nagaoka.** *Imp. Acad. Tokyo, Proc.* 12. *pp.* 218–220, *Oct.*, 1936. *In English.*—In the typical quartz spectrograph the light is collimated by a single quartz lens, hence light reaching the prism is parallel for one wave-length only, the rays of greater wave-length being divergent, those of shorter convergent. It is pointed out that if the customary single collimating lens be replaced by an achromatic doublet made up of two lenses of the same material, the two lenses being a distance $D = (f_1 + f_2)/2$ apart, then a position may be found for the slit which will result in all the radiation falling on the prism being parallel. The slit must be placed at a distance of $f_1(f_1 - f_2)/(f_1 + f_2)$ from the front lens. If, now, $f_1$ is made small then the front lens must be placed close to the slit and this results in a great increase in intensity owing to the large angle subtended at the slit by the front lens as compared with the case of a single lens at the end of the collimator tube. The collimator tube is also reduced considerably in length. In a case considered the intensity is increased some 10 times as compared with present practice. The scheme discussed should be of considerable value where faint sources are in use, or where short exposures are essential. A. H.

***732. Infra-Red Spectrometer Making Double Use of the Prism. W. Dahlke.** *Zeits. f. Instrumentenk.* 57. *pp.* 18–20, *Jan.*, 1937.—An infra-red spectrometer, in which the rays, after traversing the prism, are reflected back into it by a plane mirror, is described. The resolving power is doubled and the spectrum purified. It is shown that a wave-length calibration of the prism in terms of a scale setting is still possible. C. B. A.

***733. Symmetrical Slit of Variable Width. J. V. Hughes and S. A. McKay.** *Journ. Sci. Instruments*, 14. *pp.* 25–28, *Jan.*, 1937.—A slit designed entirely on kinematic principles is described, and all essential constructional details are given. The slit opens symmetrically to a high order of accuracy, as is shown by a table of microscope readings. AUTHORS.

***734. High-Dispersion Prism Spectrographs and Barometric Pressure. A. Elliott and W. H. B. Cameron.** *Journ. Sci. Instruments*, 14. *pp.* 28–30, *Jan.*, 1937.—Attention is drawn to the need for eliminating spectral line shifts due to changes of temperature and of barometric pressure when using a multi-prism spectrograph. Methods for accomplishing this in the case of a Littrow spectrograph are described. AUTHORS.

**735. Spectrographic Methods of Studying Unstable Compounds. Part II. R. Tsuchida.** *Chem. Soc., Japan, Bull.* 11. *pp.* 721–734, *Nov.*, 1936.—Using methods previously described [see Abstract 1678 (1935)], the aquotisation of trans-dichlorotetramine cobaltic chloride in aqueous solutions was investigated. The changes are: $[\mathrm{Co(NH_3)_4\ Cl_2}\ {}^{(1)}_{(6)}]\mathrm{Cl} \rightarrow [\mathrm{Co(NH_3)_4\ Cl\ H_2O}\ {}^{(1)}_{(6)}]\mathrm{Cl_2} \rightarrow [\mathrm{Co(NH_3)_4\ Cl\ H_2O}\ {}^{(1)}_{(2)}]\mathrm{Cl_2} \rightarrow [\mathrm{Co(NH_3)_4\ (H_2O)_2}]\mathrm{Cl_3}$. The second substance is a new unstable complex. From an analysis of the absorption curves the kinetics of the reactions is discussed. N. M. B.

**736. Spectrum Analysis of Zinc. R. Breckpot and W. Körber.** *Ann. Soc. Sci. de Bruxelles,* 56. *pp.* 384–403, *Dec.* 23, 1936.—Tables (similar to those for CuO [see Abstract 721 (1936)] are given showing the relation between the concentration of impurities (Ag, As, Bi, Cu, Fe, Ge, In, Mg, Ni, Pb, Sb, Sn, Tl) in ZnO and the relative intensities of their lines to comparison lines of Zn when the oxide is volatilised in the anode of a carbon arc with a current of 1 A. Use of the anode gives greater sensitivity than that of that of the kathode and most of the metals can be detected in concentrations of 0·001 %. Pb in concentrations of 1 % does not affect the results. H. G. C.

*See also* Abstracts 414, 447, 469, 491, 549, 576, 585, 636, 637, 647, 771, 775, 780, 781, 782, 816, 837.

## VELOCITY OF LIGHT.

*See* Abstract 522.

## VISION.

**737. Perception of Colour. P. J. Bouma.** *Philips Techn. Rev.* 1. *pp.* 283–287, *Sept.*, 1936.—The principles of colour vision are discussed in this article, consideration of the problem being limited to its qualitative aspects. An investigation is made of the conditions determining the production of a colour sensation. Following a consideration of the effect of the nature of the incident light and the characteristics of the object illuminated, the properties of the eye are discussed. It is shown that all colour sensations or impressions can be represented graphically in a planet. The effects of very low brightness levels and of simultaneous and successive contrast are then considered, and, finally, brief reference is made to the theory of colour vision. AUTHOR.

**738. Visibility of Radiation at Low Intensities. K. S. Weaver.** *J.O.S.A.* 27. *pp.* 36–43, *Jan.*, 1937.—A visibility curve depending on about 15 observers has been taken at an intensity comparable to the lowest used in darkroom work. A series of determinations of the wave-length of maximum visibility for several intensities and observers has also been made giving a curve extending from near the dark adapted threshold to about 2 foot lamberts. The observations were all made with the natural pupils and binocular vision. Comparisons with some previous work of other authors are made. The wave-length of maximum visibility at the highest intensity corresponds very closely with that of the standard I.E.S. photopic curve. At the lower levels, values are found approximating those given by König in his complete curve, and by Hecht for an intensity 2·7 times the dark adapted threshold. AUTHOR.

**739. Visibility of Various Type-Faces. M. Luckiesh and F. K. Moss.** *Frank. Inst., J.* 223. *pp.* 77–82, *Jan.*, 1937.—The authors used the Luckiesh-Moss visibility meter to determine the relative visibilities of 20 different 8-point type-faces, the illumination in each case being 10 foot-candles. Differences in visibility of the different type-faces were found in some cases to be considerable, *e.g.*, Garamond Bold was superior to Caslon Light Italic by an amount corresponding to an increase of 3 points in type size. The illumination necessary to give the same visibility for each type was also determined. W. S. S.

*See also* Abstracts 550, 655.

## X-RAYS.

**740. Calculation of the Atomic Structure Factors of Positive Ions. T. Derenzini.** *N. Cimento,* 13. *pp.* 342–348, *Aug.–Sept.–Oct.,* 1936.—The atomic structure factors of the positive ions, $Na^+$, $K^+$, $Rb^+$ and $Sr^{++}$, are calculated on the basis of an electron distribution in accordance with the Fermi statistics. The results are in accord with those obtained by the application of other methods. C. J. B. C.

**741. X-Ray Scattering Coefficients of Gases. Y. H. Woo and C. P. Sun.** *Tsing Hua Univ., Sci. Reports,* 3. *pp.* 549–553, *Dec.,* 1936. *In English.*—A numerical evaluation is made of the X-ray scattering coefficients of gases according to the intensity formula given by Debye and Heisenberg. The calculated values of the scattering coefficients of Ne, A and $O_2$ are compared with the experimental data recently obtained by Wollan. The agreement between theory and experiment is satisfactory throughout the range of wave-length examined. AUTHORS.

**742. Scattering of X-Rays by Halogen Substitution Products of Benzene. R. Schoppe.** *Zeits. f. phys. Chem.* 34. *Abt.B.* 6. *pp.* 461–470, 1936.—Observations of the scattering of X-rays in mono-, di- and tri-halogen substituted benzenes give the following results for various interatomic distances. From the mono-substituted benzenes, $C - C = 1 \cdot 42 \mp 0 \cdot 03$ Å, $C - Cl = 1 \cdot 65 \mp 0 \cdot 03$ Å, $C - Br = 1 \cdot 85 \mp 0 \cdot 04$ Å, $C - I = 2 \cdot 08 \mp 0 \cdot 04$ Å. From dicloro- and dibromo-benzenes, (*a*) in *p*-positions, $Cl - Cl = 6 \cdot 10 \mp 0 \cdot 09$ Å, $Br - Br = 6 \cdot 55 \mp 0 \cdot 09$ Å; (*b*) in *o*-positions, $Cl - Cl = 3 \cdot 30 \mp 0 \cdot 05$ Å, $Br - Br = 3 \cdot 80 \mp 0 \cdot 05$ Å; (*c*) in *m*-positions, $Cl - Cl = 5 \cdot 35 \mp 0 \cdot 08$ Å. From 1 : 2 : 4-tricloro-benzene, *o*-positions, $Cl_1 - Cl_2 = 3 \cdot 30 \mp 0 \cdot 05$ Å, *p*-positions, $Cl_1 - Cl_4 = 6 \cdot 10 \mp 0 \cdot 09$ Å. Diagrams are given of the apparatus used and the scattering curves obtained are reproduced together with the theoretical curves. J. I.

**743. Auger Effect in Xenon and Krypton. L. H. Martin and F. H. Eggleston.** *Roy. Soc., Proc.* 158*A*. *pp.* 46–54, *Jan.* 1, 1937.—An account is given of a statistical determination of the K yields of Xe and Kr carried out by means of a Wilson expansion chamber. The K yield for Xe is 0·78 and Kr 0·53. Details of the Xe count show that in the majority of cases the ejection of K and L electrons from the same atom is accompanied by the ejection of two M electrons. Implications are discussed. The experimental values of the K yield lie close to the theoretical curve expressing the variation of the K yield with atomic number. [See also Abstract 769 (1935).] AUTHORS.

**744. X-Ray Decomposition of HI and Formation of HBr. P. Günther and H. Leichter.** *Zeits. f. phys. Chem.* 34. *Abt.B.* 6. *pp.* 443–460, 1936.—The present work confirms Gotzky and Günther's earlier work on the sensitivity of explosive mixtures of $H_2$ and $C_2$ towards X-rays which indicated that the reactions were due to ionic formation. It is now shown that the quantity of HBr formed from a mixture of $H_2$ and $Br_2$ vapour under the influence of X-rays agrees with that foretold by calculation. The sensitivity towards X-rays, however, is for less than that shown by HI on decomposition. The formation of HBr also depends on the pressure of the $Br_2$ vapour while the decomposition of HI is independent of pressure. J. K.

***745. Focusing of X-Rays. W. Arkharow.** *Techn. Phys., U.S.S.R.* 3. 10. *pp.* 905–912, 1936. *In German.*—As a focusing lens for X-rays, a method is proposed which is essentially a combination of the two existing methods. The lens is a concave surface of revolution formed by the rotation of an arc of a circle about the chord defining it. The angle contained by the arc of the circle is $(\pi - \theta)$ where $\theta$ is the diffraction angle, defined by the Bragg equation, of the crystalline substance forming the surface of the lens. An attempt to use the lens is described. The results obtained are considered quite satisfactory. Numerous factors which affect the sharpness and intensity of the focus obtainable are fully discussed. In addition several applications of the lens are mentioned. G. O. B.

***746. Influence of Chemical Binding on the Form of the $L\alpha$ Lines of Copper and Nickel. E. Saur.** *Zeits. f. Physik,* 103. 7–8. *pp.* 421–433, 1936.—A high-vacuum crystal spectrograph is described with which the $L\alpha$ lines of pure Cu and Ni as well as of a series of alloys and compounds of these two metals are investigated in order to discover the influence of chemical binding. For measurement of the half value width of the lines the blackening-time curve of the Cu $L\alpha\beta$ ray, 13·2 Å, is taken for the plate material used and compared with the corresponding curves for the C $K\alpha$ ray, 44·5 Å, and the Cu $K\alpha$ ray, 1·54 Å, taken by Broili and Kiessig. Changes of the half value width of Cu $L\alpha$ up to 14 % are observed. Besides $L\alpha'$ and $L\alpha''$ of the Cu $L\alpha$ line a further component is measured which is specially prominent in Cu Be. The intensities of the components are strongly influenced by the binding, but the positions are unaffected. No change of the half value width or structure of the Ni $L\alpha$ line with binding is observed. J. E. K.

**747. Temperature and Fine Structure of K-Absorption Edge of Iron. W. Sjoerdsma.** *Physica,* 4. *pp.* 29–32, *Jan.,* 1937. *In English.*—The fine structure of the X-ray K-absorption edge of Fe is investigated for different temperatures up to 830° C. The changes observed are exactly in agreement with Kronig's theory of fine structure of X-ray absorption edges. AUTHOR.

***748. X-Ray Spectrograph with a Curved Crystal. B. Borisov and J. Fogel.** *Techn. Phys., U.S.S.R.* 3. 11. *pp.* 997–1004, 1936. *In English.*—A description is given of the design of an X-ray spectrograph with a curved crystal. This spectrograph does not require adjustment of the crystal-holder and film-holder. The method of working the spectrograph is given. Reproductions are given of K- and L-emission spectra, K-absorption spectra and K-secondary spectra obtained with a curved mica crystal spectrograph. AUTHORS.

***749. Lecture Demonstration of Optical Gratings for X-Ray Spectroscopy. W. Kossel.** *Zeits. f. techn. Physik,* 17. 11. *pp.* 429–430, 1936. *Phys. Zeits.* 37. *pp.* 855–856, *Dec.* 1, 1936.—The absolute measurement of X-ray wave-lengths depends on the production of spectra by gratings having constants several thousand times greater than the wave-lengths. An apparatus is described for lecture-room demonstration of the possibility of producing such spectra using a light beam and a grating which has a constant of the order of millimetres. J. E. K.

*See also* Abstracts 472, 625, 661, 760, 863, 885.

V.
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# HEAT.

## CALORIMETRY.

**750. Heat Capacity, Entropy and Free Energy Data of Five Higher Olefins. G. S. Parks, S. S. Todd and C. H. Shomate.** *Am. Chem. Soc., J.* 58. *pp.* 2505–2508, *Dec.*, 1936.—The specific heats of *n*-heptene-1, 1,4-pentadiene, tetramethylethylene and the two di-isobutylene isomers are measured between 80 and 298° K. The corresponding heats of fusion are also determined. The entropies of these five olefins in the liquid state at 298·1° K. are calculated from the foregoing heat capacity data. The corresponding free energies (except in the case of tetramethylethylene) are also calculated. Among the $\alpha$ olefins the free energy difference between an olefin and the corresponding paraffin is uniformly about 21,000 cal. As the number of radicals attached to the C atoms of the ethylene linkage increases this free energy of dehydrogenation falls off progressively to about 17,100 cal. as a limit. AUTHORS.

**751. Specific Heat of Iron. E. Lapp.** *Ann. de Physique*, 6. *pp.* 826–855, *Dec.*, 1936.—The method used was the same as for Ni [see Abstract 1924 (1930)], save that the electric furnace was slightly modified to allow of determinations up to 960° and the Fe wire (which contained 0·074 % C, 0·019 Si, 0·020 Mn, 0·09 Cu and 0·02 Al) was heated in a vacuum to prevent oxidation. The atomic heat increases steadily from 6·14 at 18° to 10·45 at 574°, then with increasing rapidity to 15·6 at 750·6°, after which it falls sharply with discontinuities at 790°–800° (11·36–11·40) and 913°–918° (sudden drop from 9·78 to 7·93, corresponding with the $\beta \rightarrow \gamma$ transformation); it then increases slightly to 7·94 at 960°. This last value is, after allowing for all known terms, still about one unit above 5·97. All known and "unknown" terms have been calculated as was done for Ni. C. A. S.

**752. Specific Heat of Electrons in Metals. A. Sommerfeld.** *Ann. d. Physik*, 28. 1. *pp.* 1–10, *Jan.*, 1937.—Recent theoretical and experimental contributions to this subject are presented and discussed. R. W. P.

*See also* Abstracts 469, 532.

## CONDUCTION.

**753. Exchanges of Energy Between a Platinum Surface and Hydrogen and Deuterium Molecules. W. B. Mann and W. C. Newell.** *Roy. Soc., Proc.* 158*A*. *pp.* 397–403, *Jan.* 15, 1937.—The exchange of energy between $H_2$ and $D_2$ molecules and the same Pt surface is investigated. Values of the accommodation coefficients relative to the cleaned wire at a mean temperature of 100° C., the surroundings being at room-temperature, are respectively equal to 0·11 and 0·16 for $H_2$ and $D_2$. The accommodation coefficient of He relative to the same surface is of the order of 0·05. A development of the Na method of preparation for $D_2$ is described. Its advantages are discussed with respect to the simplicity of the apparatus required, the ease with which the reaction may be controlled, and the consistent purity of the final product. AUTHORS.

*** 754. Thermal Exchanges in Nitrogen and Hydrogen under High Pressures. J. Basset.** *Comptes Rendus,* **203.** *pp.* **1338–1340,** *Dec.* **14, 1936.**—After a brief discussion of thermal conductivity measurements in general, apparatus is described for the investigation of the conduction under high pressures. A $SiO_2$ tube is placed along the axis of a high pressure vessel, and it is heated by means of a Pt spiral wound on it. This is also used to measure the temperature. The space between the two cylinders is filled with amianth fibres, the gas occupying the interstices of the fibres. Radiation is thereby prevented. The rate at which energy must be supplied to keep the temperature of the $SiO_2$ constant is measured for different pressures from 1–6000 $kg./cm.^2$, and the results are tabulated for 600° C. together with the corresponding densities. The ratio of the energy supply for $H_2$ to that for $N_2$ varies with the pressure, and has the value of 20 for pressures for which the gases have the same density. The results can only be approximate as the allowance to be made for the conductivity of the lagging is difficult to estimate. At high pressures the energy loss is approximately proportional to the quantity of matter between the cold and the hot boundaries, and it is estimated that practically the whole of the heat loss is due to conduction. E. H. D.

**755. Thermal Conductivity of Saturated Gaseous Hydrocarbons at Low Pressures. R. Delaplace.** *Comptes Rendus,* **203.** *pp.* **1505–1507,** *Dec.* **28, 1936.**—A constant alternating current is passed along a wire which includes the hot junction of a nichrome-constantan couple, and is situated along the axis of a metal tube containing the gas. The temperature attained measures the conductivity. In this way the conductivities of $H_2$, $CH_4$, $C_2H_6$, $C_3H_8$ and *n*- and *iso*-butane at pressures of 1–400 baryes were determined. Results (shown by curves) indicate that when the pressure is $< 200$ baryes the conductivity is independent thereof and of the nature of the gas for all the hydrocarbons, but for $H_2$ it is greater. Below 200 baryes, *e.g.*, for 50 baryes, the order of increasing conductivity is $H_2$, $CH_4$, $C_2H_6$, $C_3H_8$, *n*- and *iso*-butane. C. A. S.

**756. Thermal Resistance of Bismuth Single-Crystals at Low Temperatures and in a Magnetic Field. W. J. de Haas, A. N. Gerritsen and W. H. Capel.** *K. Onnes Lab., Leiden, Comm. No.* **247***c. Physica,* **3.** *pp.* **1143–1158,** *Dec.,* **1936.** *In English.*—In a previous paper [see Abstract 3553 (1935)] a method was described for the determination of the thermal resistance of metals at low temperatures, but it has led to a number of difficulties. It has therefore been superseded by a more suitable method. The single crystal used was in the form of a double cross, and the building up of the apparatus around it is described. The preparation of the crystals is briefly described together with the methods of measuring the electrical resistance and the thermal resistance, at different low temperatures, and under the influence of a magnetic field. From the results it is concluded that the purity of the lattice of the crystal is very important in thermal conductivity experiments at low temperatures; that magnetic fields have an effect in the temperature regions of liquid $N_2$ and $H_2$; in the saturation field, at the lower temperatures and within the experimental accuracy, there is no electronic thermal conductivity left; from the constancy of the Wiedemann-Franz-Lorenz figure the thermal conductivity of the electrons and of the lattice can be joined additively, and with the accuracy obtained the lattice is not disturbed by the magnetic field. E. H. D.

*See also* Abstracts 406, 496.

V.4
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## CONVECTION.

**757. Electro-Convective Cellular Vortices. D. Avsec and M. Luntz.** *Comptes Rendus*, 203. *pp.* 1140–1142, *Nov.* 30, 1936.—Arising from earlier work [see Abstract 5192 (1936)] in which the cellular cloud formation produced in the laboratory could only be maintained up to a thickness of some 10 cm., it was considered that the much greater thicknesses for which the same type of formation could be observed in natural clouds might be due to the presence of electrostatic fields. Experiments have now been carried out using oil between plane parallel electrodes maintained at different potentials. In this way cellular vortices similar to those of Bénard have been produced, and these so-called electro-convective vortices retained their regularity to much higher velocities than did those produced thermally. Other forms are produced by variations in the electrodes. R. W. P.

*See also* Abstract 545.

## DILATATION.

**758. Formulæ for Calculation of Compressibility and Thermal Dilatation. R. Gianasso.** *N. Cimento*, 13. *pp.* 355–365, *Aug.–Sept.–Oct.*, 1936.—Formulæ for the computation of the compressibility and thermal dilation of various classes of crystals are applied to a number of elements and ionic crystals. The frequency of oscillation of the atoms in the crystal is also calculated in some cases. The agreement with experiment is entirely satisfactory. C. J. B. C.

**759. Thermal Expansion of Cemented Tungsten Carbide. P. Hidnert.** *Bureau of Standards, J. of Research*, 18. *pp.* 47–52, *Jan.*, 1937.—This paper gives data on the linear thermal expansion of tungsten carbide cobalt mixtures containing about 6 and 13 per cent. of Co. These products are called "cemented tungsten carbide" or Carboloy in the United States and Widia in Germany. The expansion curves of four samples of cemented tungsten carbide are shown. Coefficients of expansion are given for various temperature ranges between 20 and 400° C. The average coefficient of expansion of cemented tungsten carbide containing 5·9 % of Co, increases from $4 \cdot 4 \times 10^{-6}$ for the range between 20 and 60° C. to $5 \cdot 9 \times 10^{-6}$ for the range between 300 and 400° C. The average coefficients of expansion of the samples of cemented tungsten carbide containing from 12·9 to 13·2 % of Co, increase from $5 \cdot 0 \times 10^{-6}$ for the range between 20 and 60° C. to $6 \cdot 7 \times 10^{-6}$ for the range between 300 and 400° C. For the range from 20 to 400° C., the average coefficients of expansion of the samples of cemented tungsten carbide containing about 13 % of cobalt are 15 % greater than the coefficient of expansion of the cemented tungsten carbide containing about 6 % Co. The rates of expansion of the samples of cemented tungsten carbide increase linearly with temperature. The rates of expansion of the cemented tungsten carbide containing 13·0 % of Co are greater than the rates for the carbide containing 5·9 % of Co. The rates of expansion of the samples of cemented tungsten carbide are greater than the rates of expansion of tungsten and considerably less than the rates of expansion of Co. AUTHOR.

**760. X-Ray Investigation of Pure Iron-Nickel Alloys. Part I. Thermal Expansion of Alloys Rich in Nickel. E. A. Owen and E. L. Yates.** *Phys. Soc., Proc.* 49. *pp.* 17–28, *Jan.* 1, 1937.—The thermal expansion of pure Fe-Ni alloys having compositions ranging between

97 and 73 atoms of Ni % is measured by the X-ray method. Close agreement is found between the expansion of the crystal lattices and the expansion of specimens of material consisting of composite masses of crystals, such as were used by previous workers who employed the ordinary methods of measurement. For the alloys examined, which were all rich in Ni, the addition of Fe to the Ni lattice is found to have two effects: (*a*) the Ni lattice expands approximately in proportion to the amount of Fe added, and (*b*) the temperature of the discontinuity in the thermal-expansion curve is raised with the addition of Fe, but not in proportion to the amount of Fe added. No change in structure takes place at the temperature of magnetic transformation; the face-centred structure persists from room-temperature through the transformation temperature up to 600° C., the highest temperature reached in the investigation. No ageing effect is observed with an alloy containing 94 atoms of Ni %, the lattice parameter showing no consistent change over a period of 15 months. AUTHORS.

*See also* Abstracts 532, 767.

## MELTING AND BOILING POINTS.

**761. Temperature Distribution in Boiling Water. W. Fritz and F. Homann.** *Phys. Zeits.* 37. *pp.* 873–878, *Dec.* 15, 1936. *From the Reichsanstalt.*—Water is contained in a Cu cylinder, having a highly reflecting Cr-plated bottom heated by an electric heater. The cylinder is closed at the top except for a pipe leading to a condenser where the steam generated is condensed and weighed. It is surrounded by a steam jacket, and long tubes of German silver, of different diameters can be fixed centrally within it, so that they extend from just above the heating surface, to well above the water surface. The temperature can be measured, by means of calibrated thermocouples, within and outside this shielding cylinder, in the steam jacket, and at a number of other points of the apparatus. One of these thermocouples can be moved up and down the axis of the cylinders, so that the temperature can be measured at all heights in the water column, and in the steam above it. The results are expressed in terms of the deviation from 100° C., and are said to be measured to 0·01° C. The temperature distribution was determined for different loadings of the heating surface, with a constant water column; for different heights of column, with constant heater loading; and for different diameters of the inside shieldng cylinder. The results are given graphically, and are compared with the saturation curves corresponding to the hydrostatic pressure at the different levels. The measured temperature distribution differs considerably from that calculated from the pressure increase. The only agreement is between the mean temperature over the whole height of the column and the temperature corresponding to the hydrostatic pressure for half the height of the water column, for different values of the column height. E. H. D.

**762. Boiling-Points of Deuterium Oxide Solutions. E. R. Smith and M. Wojciechowski.** *Bureau of Standards, J. of Research,* 17. *pp.* 841–848, *Dec.*, 1936.—The differences between the boiling points of dilute aqueous solutions of $D_2O$ and the boiling point of ordinary water are measured in the range from 0·3 to 7 % of $D_2O$. The boiling points are found to increase linearly with increase in $D_2O$, according to the equation mole % of $D_2O = 70{\cdot}9\ (\Delta T)$, where $\Delta T$ is the boiling point in °C. minus 100. The measurements, made with ebulliometers of the type devised by W. Swietoslawski, were found to offer a rapid method for the analysis of solutions of $D_2O$. The differences between the boiling points and condensation temperatures of the same solutions were measured in a differential ebulliometer which gave a fractionation equivalent to about one theoretical plate. The small separation between the vapour and liquid lines on the boiling-point-composition diagram shows that the separation of $D_2O$ by fractional distillation would require columns of extremely high efficiency. AUTHORS.

**763. Physical Properties of Isoprene. N. Bekkedahl, L. A. Wood and M. Wojciechowski.** *Bureau of Standards, J. of Research,* 17. *pp.* 883–894, *Dec.,* 1936.—Isoprene (2-methyl-1, 3-butadiene) has been prepared in a state of high purity. Physical properties determined on the freshly purified sample were as follows: boiling point, 34·076 ± ·003° C.; change of boiling point with change of pressure, $dt/dP = 0\cdot 0382°$ C. per mm. of Hg; freezing point, − 146·8 ± ·2° C.; density at 20° C., 0·6805 ± ·0001 gm./ml; refractive index at 20° C., 1·42160 ± ·00005. The molecular refraction was calculated to be 25·39. The volume expansivity was measured over the entire range of temperature between the freezing point and normal boiling point, giving the following equations:

$$V = V_0(1 + 1\cdot 393 \times 10^{-3}t + 2\cdot 79 \times 10^{-6}t^2 + 4\cdot 31 \times 10^{-9}t^3 - 5\cdot 60 \times 10^{-12}t^4)$$

$$\rho = 0\cdot 7002 - 0\cdot 9754 \times 10^{-3}t - 0\cdot 592 \times 10^{-6}t^2 + 0\cdot 525 \times 10^{-9}t^3 + 9\cdot 66 \times 10^{-12}t^4,$$

in which $V$ and $\rho$ are the volume and density, respectively, at the temperature $t$, and $V_0$ the volume at 0° C. From the Clausius-Clapeyron equation the latent heat of vaporisation at the normal boiling point was calculated to be 25·9 ± ·3 kj./mole. The refractive index at any temperature from about 0° C. to the boiling point may be calculated from the equation $n_D = 1\cdot 43472 - 0\cdot 656 \times 10^{-3}t$. On standing, the isoprene was found to undergo a transformation, presumably oxidation and polymerisation, as was indicated by changes in purity, boiling point, density, and refractive index. AUTHORS.

**764. Intensity of Orbital Interaction in Metals. R. Forrer.** *Comptes Rendus,* 203. *pp.* 1268–1270, *Dec.* 7, 1936.—The factor F in the formula T (melting point) $= \mathrm{F}\sqrt{\mathrm{N}}$ [see Abstract 4624 (1935)] is determined for elements of atomic number below 20. It is then shown that F can be expressed as $\mathrm{F}_0 + \epsilon\tau$, where $\mathrm{F}_0 = 273$, $\tau = 14$, and $\epsilon$ for Tl, Pb and Bi is the number of electrons 6*p*. In the group of elements Ag − Ba $\epsilon$ only includes the solitary 5*p* electrons; the group is divided into two subgroups with factors 287 and 259. Similarly the 4*p* group consists of groups with factors 301 and 273. The factors for the 3*p*, 2*p* and *p* groups are probably 301, 365 and 458 respectively. [See Abstract 3419 (1936) and following Abstract.] C. A. S.

**765. Intensity of Orbital Interaction in Salts. R. Forrer.** *Comptes Rendus,* 203. *pp.* 1530–1532, *Dec.* 28, 1936.—F, the intensity of orbital interaction $= \mathrm{F}_0 + \epsilon\tau$, where $\tau = 14$, and $\mathrm{F}_0$ is the value of F when $\epsilon$, the number of *p* electrons, is 0 or 6. The rare gases have levels with 6 *p* electrons, as also do the ions of elements of atomic number 1 above or below these gases, *e.g.* $\mathrm{K}^+$ and $\mathrm{Cl}^-$ in KCl. The values of $\mathrm{F}_0$ for these ions ($\mathrm{F}_i$) are calculated from the relation $\mathrm{T} = \mathrm{F}\sqrt{\mathrm{N}}$, where T is the melting point and N the number of orbital contacts, for LiH, NaF, KCl, RbBr, and CsI on the assumption that N = 4 for LiH and 12 for the others. The values of $\mathrm{F}_0$ and $\mathrm{F}_i$ (practically equal) when plotted against the principal quantum numbers (Q) fall on a hyperbola, or if against 1/Q on a straight line. By extrapolation for $\mathrm{Q} = \infty$ $\mathrm{F}_\infty$ is about 189°. $\mathrm{F}_i$

therefore only depends on the quantum number of the level of which pairs of orbits are in contact and $= F_\infty + 24\,\tau/Q$, while for metals $F = F_\infty + \tau\,(24/Q + \epsilon)$. [See preceding Abstract.] C. A. S.

**766. Volatility of Boric Acid in Water Vapour. M. v. Stackelberg, F. Quatram and J. Dressel.** *Zeits. f. Elektrochem.* 43. *pp.* 14–28, *Jan.*, 1937.—The system $B_2O_3$-water is discussed and the volatility of boric acid in water vapour is measured. The solid phases are ice-$H_3BO_3$ with a melting point of 170° C., $HBO_2$ m.p. 203° C., and glassy $B_2O_3$ containing water. The temperatures are fixed at which the vapour pressures of the water vapour of these compounds are definite. The liquidus curve is given with approximate accuracy. The heats of solution of $H_3BO_3$, $HBO_2$ ,and $B_2O_3$ aq. were measured and compared with their dependence of transition points upon temperature. The volatility of $H_3BO_3$ is considered to be due to coordinative desaturation (*Absattigung*) of the molecule. F. J. B.

*See also* Abstracts 406, 422, 767.

## TEMPERATURE, MEASUREMENT OF.

**767. Mercury-Thallium Alloys and their Use for Thermometry. H. Moser.** *Phys. Zeits.* 37. *pp.* 885–886, *Dec.* 15, 1936. *From the Reichsanstalt.*—Attention is drawn to the suitability of the Hg-Tl alloy containing 8·5 % of Tl. A table of properties is given. The most important property is the very low freezing point (− 60 ± 0·2° C.) by virtue of which thermometers containing this alloy can be used at temperatures considerably below that at which Hg becomes solid (− 38·9° C.). It is also noted that the Hg-Tl alloy containing 40·4 % of Tl (freezing point − 0·8° C.) has the special property that its vapour pressure at 500° C. is only about half of that of pure Hg. L. A. W.

**768. Determination of Gas Temperature. M. Pirani and R. Rompe.** *Am. Electrochem. Soc., Trans.* 69. *pp.* 417–431, 1936.—The difficulties which attend measurement of the temperature of a gas in which true thermal equilibrium is not attained are discussed. Consideration is given to the various forms in which energy may be transmitted through the medium and absorbed therein, reference being made to several specific cases, such as the low pressure gaseous discharge and the atomic H arc. A description is also given of some of the methods available for the measurement of temperature, together with the particular forms of energy interchange on which the observations are based. R. W. P.

## THERMOCHEMISTRY.

**769. Heats of Solution and Heats of Reaction in Liquid Ammonia. F. C. Schmidt, J. Sottysiak and H. D. Kluge.** *Am. Chem. Soc., J.* 58. *pp.* 2509–2510, *Dec.*, 1936.—The molar heats of solution of $NH_4Cl$ and $NH_4Br$ are measured in liquid $NH_3$ over a fairly wide range of concentration and show a marked heat of dilution. The molar heat of solution of ethyl alcohol is measured over a range of concentration and it is shown that this compound has a decided negative heat of dilution.

AUTHORS.

**770. Heats of Formation and of Solution of Isomeric Cobaltammines. T. C. J. Ovenston and H. Terrey.** *Chem. Soc., J. pp.* 1660–1662, *Nov.*, 1936.—The heats of formation in solution of $Na_2S$ and NaCl and $NH_3$ (or ethylenediamine) and the heat of formation of solid $CoS_3$ are experimentally determined for the equation 2 [Co(NH$_3$)$_4$ Cl$_2$]Cl + 3 Na$_2$S = Co$_2$S$_3$ + 8 NH$_3$ + 6 NaCl + 2 Q cal., thus permitting the required heat of formation to be found from Q. The apparatus used is fully described. J. K.

**771. Thermal Dissociation of NaNO$_3$, HgNO$_3$ and Ba(NO$_3$)$_2$. K. Butkow and W. Tschassowenny.** *Acta Physicochimica,* 5. 5. *pp.* 645–650, 1936. *In German.*—A previous investigation [see Abstract 5202 (1936)] had indicated that in the vapour state KNO$_3$, KNO$_2$ and AgNO$_3$ possessed covalent union between metal and nitrate radical, and the present paper records an analogous investigation of NaNO$_3$, HgNO$_3$ and Ba(NO$_3$)$_2$. Owing to the ready decomposition of these compounds, however, in the vicinity of their fusion points, the observations now recorded are not decisive for the valency problem and only the spectroscopic data are recorded together with photographs of spectra over the range of temperature investigated. H. H. Ho.

**772. Explosion Waves and Shock Waves. Part IV. Quasi-Detonation in Mixtures of Methane and Air. W. Payman and W. C. F. Shepherd.** *Roy. Soc., Proc.* 158*A*. *pp.* 348–367, *Jan.* 15, 1937. —Small and large scale experiments have been carried out to investigate the possibility of detonation in mixtures of methane and air [see Abstract 5104 (1935)], Al-cased lead azide detonators being used as the source of ignition. The resulting explosion is in many respects similar to detonation; a luminous flame propagates at a high speed through the mixture which remains at rest until arrival of the flame, a high pressure being generated. It is unlike detonation, in that the speed is not uniform and the wave or flame front is partly sustained first by the flame and then by hot particles from the detonator. Cu-cased mercury fulminate detonators do not ignite methane-air mixtures but do so and established immediate detonation in a 9·5 % mixture of CH$_4$ with O$_2$. Lead azide detonators set up detonation in this CH$_4$-O$_2$ mixture at a considerably higher rate. An explosion similar to detonation was established in large-scale experiments for a 9·1 % methane-air mixture; this quasi-detonation, so-called because the energy maintaining the wave is not wholly derived from the combustion of the methane, was propagated through quiescent mixture at a uniform rate of 1900 m./sec. and the flame was intensely luminous and accompanied by high pressure. High speeds of flame were also observed when the source of ignition was detonating electrolytic gas, and were due to the fact that the flame was propagated through mixture which was itself in rapid motion, and there was no semblance to detonation. Full experimental details are included in the paper. H. H. Ho.

**773. Influence of Pressure on the Speed of Normal Flame Propagation. L. Khitrin.** *Techn. Phys., U.S.S.R.* 3. 11. *pp.* 926–939, 1936. *In English.*—A study is made of the influence of increased pressure on the speed of flame propagation for mixtures of air with benzene and ether. It is established that the linear speed of flame propagation decreases as the pressure is increased. It is established that the mass velocity of flame propagation increases as the pressure is increased. The law of growth of the mass velocity with pressure may be expressed by a relationship of the type $m = K_1 \sqrt{p} + K_2$ where $K_1$ and $K_2$ are constants. An analysis of the results found by Ubbelohde using the burner method on mixtures of CO, C$_2$H$_2$, and CH$_4$ supports the observed effect and the type of the given relationship between the pressure and the value of the mass velocity of flame propagation for mixtures with air. The relationship between the mass velocity and the pressure is found to be in good accord with Jouguet's theoretical formula. AUTHOR.

**774. Influence of Pressure on the Spontaneous Ignition and Limits of Inflammability of Ether-Air Mixtures. D. T. A. Townend and E. A. C. Chamberlain.** *Roy. Soc., Proc.* 158*A*. *pp.* 415–429, *Jan.* 15, 1937.—The influence of varying initial pressure on the spontaneous ignition of ether-air mixtures has been found to be much the same as that observed with the higher paraffin hydrocarbons. There are two temperature ranges of spontaneous ignition, location in a higher range occurring at low pressures and at higher pressures in a lower range where normally only cool flames are propagated. The lower range with ether (180°–270°) was much below that observed with higher hydrocarbons (280°–410°). An analogy was observed between the influence of pressure on spontaneous ignition and limits of inflammability ; for at low pressures there are two ranges of inflammable mixtures, one for normal and the other for cool flames, separated by a range of mixtures which do not propagate flame ; with increase of pressure the inflammable ranges become superposed in much the same way as do the spontaneous ignition ranges. While, generally speaking, the analogy may with the normal flames be interpreted on the basis of the le Chatelier thermal view of flame propagation, the mixture of limit composition being assumed to develop just enough heat to raise the unburnt medium to its ignition point, this is doubtful in the case of the cool flames which seem to require an interpretation based on a chain mechanism. AUTHORS.

**775. Spectrographic Studies of the Explosive Combustion of Methane. J. Bell.** *Roy. Soc., Proc.* 158*A*. *pp.* 429–454, *Jan.* 15, 1937.—Detailed analytical and spectrographic investigations of explosion flames of homogeneous $CH_4-O_2$ media, burning under widely varying conditions of pressure and mixture composition, have been made. It has been shown that in the combustion of an equimolecular $CH_4$-$O_2$ mixture to $H_2O$, CO, and $H_2$, this $H_2O$ is produced by the thermal decomposition of intermediate oxidation products and not directly by the combustion of $H_2$. Moreover, by rapid cooling of the reacting media both methyl alcohol and formaldehyde have been isolated from these explosions. The steady flames of methane, methyl alcohol, and formaldehyde have been investigated spectrographically over a wide range of mixture composition, and in the case of $CH_4$, over a wide range of pressure also. The various band systems present in these spectra, the intensities of which varied both with the mixture composition and the pressure, have been shown to arise by thermal decompositions of intermediate oxidation products. The results, as a whole, have shown that the explosive combustion of $CH_4$ may be represented by a hydroxylation scheme, which, apart from thermal decompositions, is identical with that representing the course of the slow combustion. AUTHOR.

**776. Permeability of Potential Barriers to Light Particles. R. P. Bell.** *Roy. Soc., Proc.* 158*A*. *pp.* 128–136, *Jan.* 1, 1937.—A discussion is given of the range of validity of approximate expressions for the permeability of potential barriers, and it is pointed out that the errors involved in such approximations can only be evaluated by comparison with exact solutions. A formal exact solution of the wave equation is obtained for a parabolic potential barrier, but does not lend itself to calculations of the permeability. It is, however, shown that when the energy of the particle is equal to the maximum potential energy a convenient exact solution can be obtained for a more general type of barrier, and that this solution can be used to estimate the maximum error involved in the approximate treatment. It is concluded that for barriers appropriate to chemical reactions the approximate expressions can be used for semi-quantitative calculations of absolute rates and will give accurate results for the relative rates of similar reactions. In the case of a parabolic barrier these conclusions are confirmed by an independent type of asymptotic solution. [See Abstract 1205 (1935).] AUTHOR.

**777. Transfer of Energy in Molecular Systems. H. Gershinowitz.** *J. Chem. Phys.* 5. *pp.* 54–59, *Jan.*, 1937.—A method of investigating problems of energy transfer, by means of potential energy surfaces, outlined in an earlier paper (*J. Chem. Phys.* 3. *p.* 786, 1935), is extended to include a more general type of surface. The probability of energy transfer among atoms is related with the rate of change of curvature of the equipotential lines. It is shown that the relative reactivity of atoms depends on the degree of excitation of the system. An explanation is suggested for the discrepancy existing between the data on the relative efficiencies of the inert gases as obtained from sound dispersion experiments and from reaction rate measurements. AUTHOR.

**778. Atomic Reactions. K. H. Geib.** *Ergeb. d. exakt. Naturwiss.* 15. *pp.* 44–106, 1936.—After a brief introduction (I), the probabilities for the production of atoms (II) are considered under thermal dissociation in the equilibrium state, thermal reactions, photochemical disintegration, and decomposition by gas discharge. The proof of the existence of atoms (III) follows and then (IV) general considerations with respect to atomic reactions which comprise, treatment of reaction kinetics, recombination procedure, addition reactions, and exchange reactions. In (V) some experimental arrangements are considered for the investigation of atomic reactions. After (V) comes a very complete discussion of the experimental results under: (VI), H atoms which includes recombination, exchange reactions, reactions of H atoms with $O_2$ and mixtures of $O_2$ and $H_2$ and addition reactions; (VII), O atoms which includes, recombination and $O_3$ formation, exchange reactions, and addition reactions with O atoms; (VIII), N atoms; (IX), Na atoms; and (X), reactions of halogen atoms. A Bibliography of 138 references completes the paper. H. H. Ho.

*See also* Abstracts 455, 530, 788.

## THERMODYNAMICS.

**779. Matter under Very High Pressures and Temperatures. F. Hund.** *Ergeb. d. exakt. Naturwiss.* 15. *pp.* 189–228, 1936. *Zeits. f. techn. Physik*, 17. 11. *p.* 427, 1936. *Phys. Zeits.* 37. *p.* 853, *Dec.* 1, 1936.—The main paper is a comprehensive survey of the present status of our knowledge of the behaviour of matter at very high pressures and temperatures, the scope of which can be judged from the sections into which the report is divided: (1) The equation of state, general considerations, terrestrial pressures and temperatures, the temperature range of ionisation, the pressure range of atom packing, the electron gas, the neutron gas, the region of nuclear transformation, deviations from thermodynamic equilibrium, radiation; (2) Other physical properties, energy content, electrical and thermal conduction, absorption of light, energy transport; (3) Occurrence of very high pressures and temperatures, the planets, the ordinary fixed stars, the dense stars. Bibliography. In the two latter papers the relation between pressure *p*, temperature T and density *ϱ*, of matter is traced for pressures up to $10^{26}$ atm. and temperatures up to $10^{12}$ degrees. The relation is illustrated by a graph on which are indicated the naturally occurring states of matter. J. E. K.

**780. Thermal and Vapour Pressure Data for Tetramethylmethane. J. G. Aston and G. H. Messerly.** *Am. Chem. Soc., J.* 58. *pp.* 2354–2361, *Dec.*, 1936.—The heat capacities of $C(Me)_4$ is determined from 13° K. to the boiling point. The vapour pressure of the liquid is determined from the melting point to the boiling point, and an equation derived to represent the data. An equation for the vapour pressure below the freezing point is given but not considered significant. The melting point is 256·53° K. (−16·63° C.) and the boiling point 282·61° K. (9·45° C.). There is an energy absorption which is perhaps isothermal at 140·02° K. (−133·14° C.) but which is preceded by an abnormal rise in the heat capacity. The molal entropy of the ideal gas at the boiling point, calculated from the experimental data, is 71·71 ± 0·3 e.u. This value is, within experimental error, 5 R ln 2 lower than the corresponding value of 78·89 e.u. calculated from the Raman spectrum and moments of inertia. The "spectroscopic" entropy, calculated from the Raman spectrum and moments of inertia, is 80·12 e.u. per mole at 298·16° K. and 1 atm. neglecting nuclear spin. AUTHORS.

**781. Free Energy of Hydrogen Cyanide from Spectroscopic Data. A. R. Gordon.** *J. Chem. Phys.* 5. *pp.* 30–32, *Jan.*, 1937.—The free energy and heat content of gaseous HCN are computed from spectroscopic data, and the equilibrium constant for the reaction involving the formation of the gas from its elements is tabulated. The results are in good agreement with the experimental value for the free energy of formation obtained by Lewis and his associates, but are in definite disagreement with the results of Badger. The equilibrium constant for the exchange reaction with $D_2$ is also tabulated. From the spectroscopic entropy for the gas and the most recent density data, the entropy of liquid HCN is estimated. AUTHOR.

**782. Thermodynamical Properties of Carbon Dioxide. W. F. Giauque and C. J. Egan.** *J. Chem. Phys.* 5. *pp.* 45–54, *Jan.*, 1937.—An apparatus for low temperature calorimetric and vapour pressure measurements on condensed gases is described. The heat capacity of solid $CO_2$ is measured from 15 to 195° K. The heat of vaporisation at the sublimation point, 194·67° K. is found to be 6030 cal./mol. The vapour pressure is measured and the observations are closely represented by the equation : Solid $CO_2$, 154−196° K. ; $\log_{10} P$ (int. cm. Hg) $= -(1354{\cdot}210/T) + 8{\cdot}69903 + 0{\cdot}0015880T - 4{\cdot}5107 \times 10^{-6}T^2$. The entropy of $CO_2$ gas is calculated from the calorimetric data and the third law of thermodynamics to be 51·11 cal./deg./mol. at 298·1° K. This value is in excellent agreement with the value 51·07 cal./deg./mol. obtained from band spectrum data. AUTHORS.

**783. Molecular Heat, Entropy and Chemical Constant of Hydrogen Phosphide. K. Clusius and A. Frank.** *Zeits. f. phys. Chem.* 34. *Abt. B.* 6. *pp.* 405–419, 1936.—Solid $PH_3$ exists in three different states whose transformations are very probably connected with the restrained rotatability in the lattice. At 35° and 51° Abs., abnormalities occur in the molecular heat curves. From the experimental data and the statistical entropy of phosphine (neglecting nuclear spin), the thermal entropy at the boiling point of $185 \cdot 7_2$° Abs. for the ideal gas at 1 atm. pressure is given by: $S_{stat} - S_{therm} = 0 \cdot 04 \pm 0 \cdot 10$ Clausius. The difference lies entirely within the limits of error, so that no difficulties occur by the application of the Nernst heat theorem to $PH_3$. This result is also at the same time an indirect proof that the moment of inertia of $PH_3$ about the main axis must lie very near to $8 \cdot 26 \times 10^{-40}$ gm.cm.$^2$. Values were obtained from measurements of the molecular heats which lay regularly on a curve, while a transformation point occurred at 37·0° Abs. These observations are opined to be due to the formation of congealed phases which, through deficient orientation of the lattice framework, lead in many gases to too small calorimetric entropy values. H. H. Ho.

**784. Molecular Heats, Entropy and Chemical Constant of Hydrogen Sulphide. K. Clusius and A. Frank.** *Zeits. f. phys. Chem.* 34. *Abt.B.* 6. *pp.* 420–431, 1936.—The molecular heats and heats of transformation of solid $H_2S$, which exists in three modifications, are investigated. For $H_2S$ the doubtful entropy value is within the limits of error, whilst that for the analogously constituted water is not the case. According to Giauque and Ashley, the zero point rotation of the ortho-water molecule should give rise to an entropy difference of $0 \cdot 75 \text{ R ln } 2 = 1 \cdot 03$ Clausius, and the authors opine that an exact determination of the thermocalorific properties of $D_2O$ would confirm the validity of such a conclusion, since on analogy $D_2O$ should have $\Delta S_{stat.-therm.} = 0 \cdot 333 \text{ R ln } 2 = 0 \cdot 46$ Clausius, and depends on the zero-point rotation of the para-$D_2O$ molecule. An alternative explanation is offered, *viz.*, that ordinary ice I is metastable at low temperatures, and that the possible ice II (according to the phase diagram) does not form on account of the too small reaction velocity. If this interpretation be correct, then almost the same entropy difference for $S_{stat.-therm.}$ is to be expected. The corresponding difficulty for $H_2S$ does not occur. H. H. Ho.

**785. Thermodynamics of Cadmium Chloride in Aqueous Solution from E.M.F. Measurements. H. S. Harned and Margaret E. Fitzgerald.** *Am. Chem. Soc., J.* 58. *pp.* 2624–2629, *Dec.*, 1936. Measurements are made of the cells Cd–$Hg_x$Cd (11 %) | $CdCl_2$ ($m$) | AgCl–Ag from 0 to 40° and at concentrations from 0·0005 to 1 $M$. The standard potential of the cell from 0 to 40° is computed by a method which assumes incomplete dissociation of an intermediate ion, the dissociation constant of which was estimated to be 0·013, 0·011 and 0·010 at 0, 25 and 40° respectively. The standard potential of the electrode: $Cd_\gamma(s) \mid Cd^{++}$, is computed from 0 to 40°. The relative partial molal heat content and specific heat of Cd $Cl_2$ in aqueous solution are calculated. AUTHORS.

**786. Application of Thermomechanics to Electrochemistry. J. E. Verschaffelt.** *Bull. de l'Acad. royale de Belgique*, 22. 10. *pp.* 1002–1013, 1936.—A theoretical application of thermodynamic potential to electrochemical equilibria. F. J. B.

*See also* Abstracts 473, 520, 521, 750, 777, 790.

## VAPOUR PRESSURE.

**787. Vapour Pressures of Saturated Solutions. A. E. Hirschler.** *Am. Chem. Soc., J.* 58. *pp.* 2472–2474, *Dec.*, 1936.—An explanation is offered for the parallelism of the log $P$–$1/T$ curves for some saturated aqueous solutions and pure water. An equation is developed from which it is predicted that this phenomenon will be true in general for saturated solutions, both aqueous and non-aqueous. It is suggested that in the absence of data, a knowledge of the vapour pressure of a saturated solution at one temperature will make it possible to obtain the entire curve to a good degree of approximation. AUTHOR.

**788. Low Pressure Molecular State of Acetic Acid Vapour. F. H. MacDougall.** *Am. Chem. Soc., J.* 58. *pp.* 2585–2591, *Dec.,* 1936.—Values of $pV$ are determined for the vapour of very pure acetic acid at 25, 30, 35 and 40° and at pressures as low as 3 mm. The equilibrium constant for the reaction : $(HOAc)_2 \rightleftharpoons 2HOAc$, is determined for 25, 30, 35 and 40°. The heat of dissociation is calculated to be about 16,400 cal. The vapour pressure of acetic acid is measured at 25, 30, 35 and 40°. The heat of vaporisation per 120 gm. of acid at these temperatures is calculated to be 11,000, 11,110, 11,190 and 11,270 cal. AUTHOR.

**789. Liquid-Vapour Equilibrium for the System Argon-Oxygen. Pauline Bourbo and I. Ischkin.** *Physica,* 3. *pp.* 1067–1081, *Dec.,* 1936. *Phys. Zeits. d. Sowjetunion,* 10. 3. *pp.* 271–291, 1936. *In German.*—The final condensation pressure for $O_2$-A mixtures is determined at temperatures of from 87·1 to 96·3° K. The logarithm of this pressure is a linear function of $1/T$. It is shown that this system belongs to the class of regular solutions for which the compositions of the vapour and liquid phases conform to an equation suggested by Hildebrand. R. W. P.

**790. Vapour Pressures of Liquid Krypton. J. J. Meihuizen and C. A. Crommelin.** *K. Onnes Lab. Leiden, Comm. No.* 245c. *Physica,* 4. *pp.* 1–4, *Jan.,* 1937. *In English.*—Vapour pressures of liquid Kr are determined and expressed in a formula. The critical point, boiling point and triple point are given. AUTHORS.

*See also* Abstracts 530, 533, 761, 766, 780.

# ACOUSTICS.

**791. Strike Note of Bells. A. T. Jones.** *Acoustical Soc. of America, J.* 8. *pp.* 199–203, *Jan.*, 1937.—In view of a paper by Meyer and Klaes [see Abstract 4988 (1933)] certain arguments are re-examined against the view that the strike note of a bell is a difference tone. The work of Meyer and Klaes is summarised, and four new tests are reported. The results of all four tests are opposed to the hypothesis that the strike note is a difference tone. In a very tentative way the possibility is suggested that in some bells the strike note may be the second partial tone of the bell. This is not true for the bells which the author has examined most carefully. For these bells he still believes that the strike note, aside from the octave in which it lies, is determined by the fifth partial tone of the bell. As to the octave, the work of Meyer and Klaes suggests that this may be determined by the difference tone from the fifth and seventh partials, this difference tone being produced by the non-linear response of the auditor's ear. An Appendix gives some information regarding harmonic overtones from tuning forks. AUTHOR.

**792. Magnetostrictive Oscillation of Quartz Plates. R. C. Colwell and L. R. Hill.** *J. of Applied Physics,* 8. *pp.* 68–70, *Jan.*, 1937.—Small quartz plates were vibrated by mechanical impact from magnetostrictive rods cut to the proper lengths. Sand scattered on the plates gathered at the nodal lines and produced figures similar to those on Chladni plates. The quartz plates were then vibrated in an electrical field produced by the same valve circuit which was used to vibrate the magnetostrictive rods. Electrical and mechanical vibrations gave exactly similar patterns on each crystal provided the frequencies were identical. AUTHORS.

**793. Singing Flames. Z. Carrière.** *Rev. d'Acoustique,* 5. *pp.* 112–138, *May–July,* 1936.—An experimental study is made of the generation of notes by singing flames in the absence of acoustic resonators. Three types of flame are used (1) a single flame with an obstacle consisting of a metal wire held in it; (2) two flames impinging on each other; (3) a small jet burning by itself. The various phenomena obtained are illustrated with a number of photographs and results showing the relation between the frequency of the sound emitted and the pressure, dimensions of jet, etc., are given. J. E. R. C.

**794. Eddy Formation by Edge Tones. F. Krüger and H. Casper.** *Zeits. f. techn. Physik,* 17. 11. *pp.* 416–423, 1936. *Phys. Zeits.* 37. *pp.* 842–849, *Dec.* 1, 1936.—Experimental and theoretical work made in connection with the formation of slit and edge tones is reviewed. To test the v. Kármán theory of the instability of eddy series experiments are made with a special camera which can take up to 3000 photographs per sec. and is used to photograph successive stages in the formation of tones when air from a slit is directed towards an edge. The authors conclude that the theory is proved by their experiments. The relation between eddy formation in a sensitive flame and eddy formation in edge tones is pointed out. J. E. R. C.

**795. Theory of the Haskell Organ Pipe. A. T. Jones.** *Acoustical Soc. of America, J.* 8. *pp.* 196–198, *Jan.*, 1937.—A quarter of a century ago William Haskell developed an organ pipe which is like an ordinary open pipe with a smaller tube, closed at the top, inserted in it. This pipe gives the full series of harmonic partials usually obtained from an open pipe of length equal to the sum of the lengths of the outer tube and the inner one. The theory of the pipe is here developed and checked experimentally. AUTHOR.

**796. Beginning of Sound in Organ Pipes. F. Trendelenburg.** *Zeits. f. techn. Physik,* 17. 12. *pp.* 578–580, 1936.—Oscillogram records are shown of the wave-forms of sounds as they begin in organ pipes belonging to different stops of an organ in Charlottenburg. These exhibit great differences; in a flute stop the beginning is slow and uncertain, in another, a reed stop, it is rapid and exact. Many stops, *e.g., Lieblich Gedacht* begin with a different quality from that given when the notes are sounding steadily. The significance of the results in organ playing is pointed out. G. E. A.

**797. Resonance Properties of Bowed Instruments. H. Backhaus.** *Zeits. f. techn. Physik,* 17. 12. *pp.* 573–578, 1936.—An experimental study in which the amplitudes of the sounds emitted by bowed instruments under uniform conditions of excitation are measured over a wide range of frequency. The amplitude-frequency curves show many resonance maxima, and violins agree in having two main maxima, one about 260 and the loudest about 500~. By filtering out the fundamental in the case of a " wolf " tone, heard often in cellos, it was shown that this effect is caused by beats produced by a vibrating system which has two degrees of freedom, in this case the violin body and the strings. G. E. A.

**798. New Stringed Instruments. D. Raïsky.** *Comptes Rendus,* 203. *pp.* 1137–1138, *Nov.* 30, 1936.—A description is given of a compact new stringed instrument, the 'violon-basse,' designed to give good quality tones at frequencies as low as 64~. The instrument has the form of a violin and is played as such. The belly is considerable deeper, however, and the bridge somewhat higher. The maximum length of string being 37·5 cm., special loading is necessary to obtain low frequencies with good power. J. E. R. C.

**799. Velocity of Sound by the Fizeau Toothed-Wheel Method. H. K. Schilling.** *Am. Phys. Teacher,* 4. *pp.* 206–208, *Dec.,* 1936.—An adaptation of Fizeau's method of determining the velocity of light is described for measuring the velocity of sound. Sound from a Galton whistle passes through the toothed wheel into a tube of variable length and after reflection returns through the toothed wheel. The speed of the wheel is adjusted until the reflected sound is either a maximum or a minimum. The experiment is intended for classroom or lecture-room use. J. E. R. C.

**800. Visibility of Ultrasonic Waves in Liquids. S. Parthasarathy and N. S. N. Nath.** *Indian Acad. Sci., Proc.* 4*A*. *pp.* 555–561, *Nov.*, 1936.—From photographs of ultrasonic waves in liquids it is shown that the Hiedemann effect repeats at intervals $d = \lambda_s^2/2\lambda$ for standing waves, in agreement with the theory given by Nath in an appendix. Further, doubling, trebling and quadrupling of the lines have been observed at distances $d/2$, $2d/3$ and $3d/4$ respectively. The effects of changes in supersonic intensity and obliquity are observed and discussed. The lines as seen are sharp, although theory gives broad lines. Photographs of the sound field by the schlieren method are also reproduced. G. E. A.

**801. Production of Disperse Metallic States by Supersonic Vibrations. B. Claus and E. Schmidt.** *Kolloid-Beihefte,* 45. 1–3. *pp.* 41–59, 1936.—The dispersive effect of piezo-oscillators on solid and liquid substances has been investigated by means of the direct and indirect atomising methods. Na, K and Hg emulsions were prepared by the direct method. It was found that with extension of time of treatment the particle size decreased, but that the amount of dust and thereby the yield increased. Qualitative experiments by means of the indirect method, in conjunction with an electrolytic separation process, gave dust of various metals at the kathode, such as A2, Cr, Te, Ni, Cu, Mn, Ag, Cd, Pt, Au, Hg, Pb and Bi, in colloidal form ; the degree of dispersion could be varied widely according to the conditions of preparation. The use of a clean polished electrode of such material as could be galvanised only with difficulty or feebly affected by the oscillations are shown to be of special importance, for the preparation of highly dispersed systems. The comparison of both methods indicated that the direct process should be used solely for emulsions and the indirect method exclusively for the production of suspensions and colloids. The paper is replete with experimental detail. H. H. Ho.

**802. Supersonic Vibrations in Scientific Research. L. Bergmann.** *Zeits. f. techn. Physik,* 17. 12. *pp.* 512–518, 1936.—Recent advances in supersonics are recounted. Methods of excitation, detection, and measurement of velocity of supersonic vibrations are described. The value of supersonics in various branches of pure and applied scientific research is pointed out and illustrated by short accounts of work already done on the determination of elastic constants at supersonic frequencies, the preparation of colloids and the biological and chemical uses of h.f. sound. K. M. C.

**803. Supersonic Vibrations on the Surface of Solids. H. Ludloff.** *Zeits. f. techn. Physik,* 17. 12. *pp.* 518–522, 1936.—Earlier experiments have shown that supersonic vibrations in solid bodies are accompanied by waves on the surface of the solid which cause interference patterns to be formed in light reflected from the surface. By means of general theoretical considerations of the propagation of waves in isotropic and anisotropic solids the interference pattern to be expected when light is reflected from the surface of vibrating solids is calculated. Experiments carried out with quartz show that the interference patterns obtained agree with those calculated by the author's method. The possibility of determining by this means the elastic constants of opaque bodies is pointed out. K. M. C.

**804. Effect of Distribution of Absorbents and of Room Shape Upon Room Acoustics. I. Dreisen.** *Techn. Phys., U.S.S.R.* 3. 8. *pp.* 743–753, 1936. *In English.*—A theoretical treatment with some experimental results upon the effect of various distributions of absorbents and of abnormal shape upon the acoustics of rooms with special reference to broadcasting and sound-recording studios and reverberation chambers. The polar characteristics of reverberation in the large studio in Leningrad are given for a frequency of 512 ∼ and are compared with those of a similar studio at Simferopol where the absorbers consist of Békésy screens of canvas membranes stretched over cotton wadding. Uniform distribution of absorbent and normally-shaped rooms are especially desirable when the positions of microphone and artist are not permanent. A uniform frequency characteristic of the studio must also be combined with uniform absorption in order to give very high quality transmission. W. H. Ge.

**805. Sound Insulation of Single and Complex Partitions. J. E. R. Constable and G. H. Aston.** *Phil. Mag.* **23.** *pp.* 161–181, *Jan.*, 1937.—Results of measurements made at the National Physical Laboratory of the sound insulating value of a number of partitions are given together with curves which exhibit the correlation between the sound insulation and weight of single homogeneous partitions. The results are discussed and certain principles which should be adopted in sound insulating constructions are deduced. AUTHORS.

**806. Philips-Miller System of Sound Recording. R. Vermeulen.** *Soc. Franç. Phot. et Ciné., Bull.* **23.** *pp.* 210–226, *Oct.*, 1936.—The Philimil film consists of a transparent celluloid film carrying a transparent gelatin layer about 60 $\mu$ thick covered by an opaque layer about 3 $\mu$ thick. On this the sound track is cut by a chisel device, something like that used in making gramophone records, except that the chisel cutter moves up and down perpendicularly to the film. The cutting edge is so shaped that in recording, the opaque layer is removed to give a translucent track, symmetrical about the direction of motion of the film, but of varying width according to the instantaneous height of the chisel above the celluloid. (5 diagrams are given). Some advantages claimed are, long length of one recording (30–60 min.), ease of making cuts, and reproductions (photographically), sharpness of edges of track and greater freedom from graininess ground noise difficulties, and freedom from linear distortion. The operations can be carried out in daylight and the film can be at once played back. It could also be used for delayed radio reproduction of topical events or for repetition of programmes. W. H. Ge.

**807. Weak Sounds. F. Canac.** *Rev. d'Acoustique,* **5.** *pp.* 81–98, *May–July,* 1936.—If the Weber-Fechner law were correct the ratio of the least perceptible increment in sound intensity to the actual intensity of the sound should be constant. The author describes an experimental method of testing this relation for weak sounds. The method consists of noting the distance at which a plane reflector must be placed from the ear in order that the change of loudness it produces is just perceptible. It is shown that very much larger fractional increases in the intensity are necessary for weak than for medium loudness sounds. Results are given for a number of sounds, *e.g.*, the noise due to a train 1 km. away. An acoustic comparator is described which can be used for obtaining small increments in a pure tone. In this apparatus a tube is adjusted to resonance with the note and a small probe tube is passed down its axis. Movements of the probe tube then produce calculable changes in intensity. A study is also made of the effect of parasite noises and the value of amplifying a mixture of tone and parasite tone is examined. J. E. R. C.

**808. Aural Harmonics. S. S. Stevens and E. B. Newman.** *Nat. Acad. Sci., Proc.* **22.** *pp.* 668–672, *Nov.*, 1936.—The aural harmonics were observed by noting the potential generated in the cochleas of animals in a state of anæsthesia. One electrode was in contact with the round window and the other with the muscles of the neck. The potentials were amplified and led to an oscillograph and to a wave analyser. On stimulating the ear with pure tones of 1000 cycles, graphs were obtained which give the response of the cochlea in db below the maximum of the fundamental in terms of the intensity of the stimulus in db above threshold. The graphs for cat and guinea pig are similar in course, and show an increase in response consequent on an increase in stimulus. In both cases five harmonics are shown, and the odd harmonics appear to increase as the amplitude approaches the elastic limits of the auditory mechanism. The even harmonics reach a maximum before this. The presence of the even harmonics indicates that the limit is reached more quickly in one direction than in the other, and experiment showed that alteration of the tension of the tensor tympani produced a marked decrease in the amount of second harmonic but left the third harmonic unchanged. Similarly with the fourth and fifth. It is concluded that the presence of the even harmonics is due to tension in the muscles of the middle ear, with other factors. G. E. A.

**809. Psychology of Music. C. E. Seashore.** *Science*, **84.** *pp.* 517–522, *Dec.* 11, **1936.**—A review of the implications of the modern technique of sound control developed in the last ten years, both in recording, analysis and synthesis; the latter in the novel arrangements for producing artificial tone, resulting in more economical types of organ. The same technique of amplification has led to new investigations of the transmission of nerve impulses, and other matters of direct interest to psychologists, such as the definition of tone quality and a new type of musical score and the gap between the physical nature of a tone and its perception as music. It is suggested that the artistic basis of music resides in the controlled deviations from the basic attributes of a physical sound, which are pitch, intensity, duration, and wave-form. All these can now be measured, resulting in standard norms for comparison with tests and methods of training for making adjustments. Applications of the underlying sciences to the fine arts and æsthetics is hinted at. L. E. C. H.

**810. Physiology of Hearing. G. v. Békésy.** *Zeits. f. techn. Physik*, 17. 12. *pp.* 522–528, 1936.—A short review dealing with the anatomy of the ear, measurements of the threshold of hearing, protective action of the middle ear, mechanical analysis of frequencies in the cochlea, bioelectric phenomena in the cochlea and nerve currents. It is pointed out that the questions of loudness and of frequency analysis so important for telephone engineers, are intimately connected with corresponding problems in physiology, and that combined efforts are necessary for their solution. G. E. A.

**811. Symmetry and Heredity Problems of the Human Ear. E. Waetzmann.** *Zeits. f. techn. Physik*, 17. 12. *pp.* 549–553, 1936.—An examination of the hearing of each ear of a mother and son, both of whom were known to have a defect of hearing. In both cases there is marked symmetry between the two ears in their curves of threshold of pressure and absorption coefficient, although the hearing of the mother was more defective than that of the son. Also, in spite of the different degrees of deafness, the curves of threshold of pressure, absorption and of change of phase between the wave incident on the tympanum and the reflected wave all exhibit a remarkable similarity. G. E. A.

**812. Positions of Stimulation in the Cochlea by Pure Tones. J. C. Steinberg.** *Acoustical Soc. of America, J.* 8. *pp.* 176–180, *Jan.*, 1937.—The relation between tone frequency and position of stimulation on the basilar membrane has been calculated from data on differential pitch sensitivity. The calculations involve assumptions concerning the choice of the upper and lower pitch limits of hearing and the choice of tone levels which should be used in obtaining differential pitch sensitivity data. It is shown that for quite different assumptions the positions of stimulation for tones in the range from 500 to 10,000 cycles are not greatly affected. Outside this range the positions depend on the assumptions. The calculated positions for tones of 1000, 2000 and 4000 cycles fall, respectively, at points on the membrane about $\frac{1}{4}$, $\frac{1}{2}$ and $\frac{3}{4}$ of its length away from the helicotrema. The calculated positions are compared with positions obtained from post-mortem studies of human cochlea and with positions obtained from electric response measurements on the cochlea of anesthetised guinea pigs. The differences between various methods for the most part are no larger than calculated differences between observers. AUTHOR.

**813. Radiation Pressure and "Tension." L. Brillouin.** *Rev. d'Acoustique*, 5. *pp.* 99–111, *May–July*, 1936.—The general formula of Boltzmann: $\tau \overline{E} =$ constant, where $\tau$ and $\overline{E}$ are the period and mean kinetic energy respectively, is used to calculate the pressure due to radiation falling upon reflective and absorbent surfaces. Certain errors in Rayleigh's calculation of these pressures are pointed out and a formula is given for the pressure exerted by radiation on a surface which is parallel to its direction of propagation. It is suggested that since the pressure is different from ordinary pressures in that its magnitude depends upon its direction it would be better to use another word for it and "tension" is proposed for this purpose. J. E. R. C.

**814. Absorption of Sound in Gases. H. Oberst.** *Zeits. f. techn. Physik*, 17. 12. *pp.* 580–582, 1936.—Measurements are described of the absorption of sound in a gas contained in a tube. The sound is excited by a loud-speaker placed at one end of the tube and having a diaphragm so heavy that reaction upon the diaphragm can be neglected. A condenser microphone at the other end of the tube serves to determine the response. The absorption at various frequencies in the range 700–4000 ~ is deduced from the breadth of selected resonances of the gas contained in the tube. To minimise absorption by the tube walls tubes of thick brass or glass are used. In one series of measurements $N_2$ at a range of pressures is used. Since molecular absorption can be neglected in this gas the absorption deduced should agree with that predicted from Kirchhoff's formula. Actually the measured absorption is about 15 % higher. Measurements are also made in dry and moist $O_2$ and results which agree well with those of Kneser and Knudsen are obtained. It is suggested that this experimental method would be suitable for determining molecular absorption in gases. J. E. R. C.

**815. Modified Tube Method for Measurement of Sound Absorption. K. C. Morrical.** *Acoustical Soc. of America, J.* 8. *pp.* 162–171, *Jan.*, 1937.—Sound from a loud-speaker travels down a cast-iron tube 8 in. in dia., strikes the specimen under test at an angle of 45° and is reflected down a side tube where it is measured. By measuring the sound reflected down the side tube from a thick glass plate, and by measuring the sound in the side tube when an exponential horn is substituted for the specimen, it is possible to arrive at the reflectivity and consequently the absorptivity of the specimen. An earlier apparatus has been redesigned and measurements have been taken on a large number of materials. For the frequency of 500 c.p.s. the method has given absorptivities for commercial materials that are in satisfactory agreement with those determined by reverberation measurements. AUTHOR.

*See also* Abstracts 542, 772.

# ELECTRICITY AND MAGNETISM.

## CONDUCTION AND DISCHARGE IN GASES.

**816. Spark Formed with the Surface of an Electrolyte as Negative Pole. P. Jolibois and R. Bossuet.** *Comptes Rendus*, 203. *pp.* 1497–1498, *Dec.* 28, 1936.—When a high potential spark is formed with an electrolyte as the kathode [see Abstract 2319 (1936)] the luminous region in the liquid shows both H and O lines. These elements recombine at the point of impact of the spark with the fine spray projected from the liquid give rise to spectra similar to those of flames. The intensity of the spectra of metals in the electrolyte depends on the presence of other substances. Acetic acid diminishes, $NH_4Cl$ increases it. For concentrations of Mn from 2 to 100 mg./l. in *N* solution of $NH_4Cl$ the photographic blackening for 2798 is almost a linear function of the log. of the concentration. The experimental conditions are accurately reproducible and the method is suggested for the measurement of the concentration of metals in solution. H. G. C.

**817. Striking of a Gas Discharge with Alternating Potential and with Periodic Irradiation. W. Fucks.** *Zeits. f. Physik*, 103. 11–12. *pp.* 709–727, 1936.—Qualitative measurements and calculations have shown that the striking potential of a gas discharge with alternating potentials is higher than that for constant potential under comparable conditions. The Townsend discharge theory is extended to the case of alternating potentials and the formula derived : $\gamma[e^{\alpha L} \cos (\omega L/u) - 1] = 1$, where $\gamma$ and $\alpha$ are the electron collision ionisation coefficients for the kathode and gas respectively, $\omega = 2\pi f$, $u$ is the ionic velocity, and L the electrode separation. The formula is only valid when $(fL/u)^2 \ll 1$. When $\omega = 0$, the formula reduces to the known formula of Townsend for constant potentials ; when $\omega$ increases the formula indicates an increase in the striking potential. If the kathode is periodically irradiated the calculations indicate that the striking potential is independent of the irradiation frequency and equal to that found under constant irradiation. The calculations are compared with published experimental results. J. E. R.

**818. Lowering of Arc Striking Potential by Irradiation. W. Fucks and W. Seitz.** *Zeits. f. techn. Physik*, 17. 11. *pp.* 387–391, 1936. *Phys. Zeits.* 37. *pp.* 813–817, *Dec.* 1, 1936.—In a previous paper [see Abstract 5644 (1936)] experiments were described which showed that the striking potential of an arc could be raised or lowered by means of u.v. irradiation, according to the gas pressure in the discharge tube. The present work is a theoretical consideration of this problem, and the experimental results are discussed in detail. The theory suggests that the increase in striking potential is connected with the known decrease in negative ionisation due to field distortion at high values of $E/p$, where E is the field strength and $p$ the gas pressure. J. E. R.

**819. Sparking Potentials at Ultra-High Frequencies. J. Thomson.** *Phil. Mag.* 23. *pp.* 1–24, *Jan.*, 1937.—Previous observations on h.f. sparking potentials at low gas pressures are extended to much higher frequencies of the order of 10 to 100 Mc./sec. Apparatus and experiments are described to show the variation of sparking potential in a parallel electrode $H_2$-tube with gas pressure, electrode spacing and voltage frequency. It is found that polarisation effects which lead to inaccuracies in d.c. measurements are not present at high frequencies. The curve of $V_s$ against $p$ at low frequencies has two minima, but at higher frequencies there is only one minimum, and above this minimum pressure the curves are straight lines represented by the formula: $V_s = f(\nu) + \phi(\nu)pd$. $f(\nu)$ and $\phi(\nu)$ vary very slowly over a considerable range of frequencies and when $\phi(\nu)$ is almost constant it has a value in $H_2$ of 18 V/cm./mm. Hg. A theory of the discharge process is outlined, suggesting: (*a*) The field strength between parallel electrodes is non-uniform, even before the discharge occurs. (*b*) Ionising electrons during the building up of the discharge traverse linear paths, with a free path in $H_2$, 12 times the kinetic theory mean free path. (*c*) In the case of a d.c. discharge electron path is 6 times the kinetic mean free path. (*d*) At very high frequencies the long ionising free path is no longer possible. The agreement between theory and experiment is satisfactory. J. E. R.

**820. Examination of Negative Ions in the Gas Discharge at Higher Pressures with a Mass Spectrograph. O. Tüxen.** *Zeits. f. Physik*, 103. 7–8. *pp.* 463–484, 1936.—Using a discharge tube with a pierced anode, the negative ions produced at pressures from 0·1 to 10 tor. were examined with a mass spectrograph. In air, the negative ions $O^-$, $O_2^-$, $NO_2^-$ and $NO_3^-$ were recorded while in $H_2$ a few $H^-$ ions were found. No negative ions were found in the rare gases, but the existence of the positive particles $He_2^+$, $Ne_2^+$ and $A_2^+$ were established. F. C. C.

**821. Variation of Recombination Coefficient for Air and $CO_2$ with Pressure and Temperature. W. Mächler.** *Zeits. f. Physik*, 104. 1–2. *pp.* 1–33, 1936.—The variation of the ionic recombination coefficient for air and $CO_2$ was found for pressures ranging from 5 to 25 atm. and for temperatures between 18° C. and 52° C. The accuracy was about 1 % and the ion concentration varied from $4 \times 10^4$ to $8 \times 10^5$ ions cc. Current potential characteristics were found using a parallel plate condenser fitted with a guard ring and the dependence of the temperature coefficient $\beta = di/i.\,dT$ on field strength and gas pressure was examined. F. C. C.

**822. Electron and Negative Ion Mobilities in Oxygen, Air, Nitrous Oxide and Ammonia. R. A. Nielsen and N. E. Bradbury.** *Phys. Rev.* 51. *pp.* 69–75, *Jan.* 15, 1937.—The electrical shutter method [see Abstract 316 (1937)] for measuring electron mobilities in gases has been extended to include experiments in $O_2$, air, $N_2O$ and $NH_3$. The experimental data support the hypothesis that collisions of low energy electrons with molecules of these gases may be inelastic. Such collisions cause excitation of vibrational levels, electronic levels, or dissociation of the molecule. The results are compared with experiments reported elsewhere on negative ion formation in these gases. In general the onset of negative ion formation is accompanied by inelastic collisions which result in a marked increase in the electron drift velocity. Negative ion mobilities in these gases have been measured in the same apparatus by an adaptation of the Rutherford a.c. method. The ions were formed by electron attachment in an auxiliary field and their mobility determined at various ages. The probable character of the ions is discussed after comparing the experimental results with those predicted by the Langevin theory. AUTHORS.

**823. Electron Emission of an Oxide Kathode in an Arc Discharge. M. J. Druyvesteyn and N. Warmoltz.** *Physica*, 4. *pp.* 41–50, *Jan.*, 1937. *English Abstract.*—The electron emission of an oxide coated kathode in an arc discharge is determined by measuring the arc voltage as a function of the arc current; the temperature and other properties of the kathode are not altered by this measurement, as the current passes only during $10^{-4}$ sec. through the arc. In a certain current range the voltage on the arc is independent of the current, till at a definite current the voltage begins to rise with increasing current; at still higher current a very steep rise occurs. At a low pressure ($< 0{\cdot}02$ mm. of A) the constant voltage part disappears. The results can be explained by the hypothesis that an accelerating electric field (for the electrons) does not appear at the same arc current for all parts of the oxide surface, as this surface is very rough. AUTHORS.

**824. New Dark Space near Glowing Kathode in an Arc Discharge. M. J. Druyvesteyn and N. Warmoltz.** *Physica*, 4. *pp.* 51–68, *Jan.*, 1937. *English Abstract.*—A new dark space round the oxide coated kathode of an arc in noble gases and Hg vapour is described. This dark space occurs at a current density higher than $0 \cdot 1$ A/cm.$^2$ and a pressure between $10^{-2}$ mm. and 3 mm. The thickness of this dark sheath is about 20 times that of the space charge sheath at the kathode. At lower pressure the new dark sheath disappears and a bright sheath of the same dimensions is seen. Coming from the kathode, a sharp increase of the concentration and a decrease of the mean energy of the fast electrons is observed at the limit of the sheath; with the aid of these electrical results the optical phenomena can be explained. The electrical behaviour can be explained by the scattering of the group of fast electrons which starts at the boundary of the space charge layer on the kathode; this scattering increases with increasing arc current. AUTHORS.

**825. Probe Measurements on High-Pressure Arcs. R. C. Mason.** *Phys. Rev.* 51. *pp.* 28–42, *Jan.* 1, 1937.—Experiments show that the introduction of a probe into a carbon arc at atmospheric pressures increases the arc voltage, the increase depending on the size of the probe, but not on the rate at which it moves in the arc. It is shown that this effect is due to the local cooling of the gas, the probe being surrounded by a dark space of cold gas in which little ionisation takes place. The rate of flow of energy to a probe in a carbon arc was measured and it is shown that half the energy is carried by thermal conduction across the dark space, and half comes from recombination of dissociated molecules on the probe surface. In view of these difficulties it is suggested that the interpretation of probe current-voltage characteristics developed for low pressure discharges cannot be used at high pressures. A qualitative explanation is, however, given for the characteristics of the arc used. J. E. R.

**826. Discharge Delay in Uniform Fields for Large Spark-Gap Lengths. R. Strigel.** *Wiss. Veröff. a.d. Siemens-Werken*, 15. 3. *pp.* 1-12, 1936.—The discharge delay was investigated for sphere and plate spark-gaps and for gap widths of 1 to 6 cm. The building-up time was found to be practically independent of the gap width in this range. For slight excess voltages it was found to be of the order of 100 $\mu$s, but with increasing excess voltage the building-up time decreased rapidly and for 60 % excess voltage was only about 30 $\mu$s. It was also found to be independent of the surface area of the electrodes and of the radiation from a

Hg-vapour lamp. The results are discussed and a new view of the nature of the physical processes occurring during the building-up time is presented. [See following Abstract.] A. W.

**827. Discharge Delay in Non-Uniform Fields. R. Strigel.** *Wiss. Veröff. a.d. Siemens-Werken,* 15. 3. *pp.* 13–31, 1936.—In a previous paper [see preceding Abstract] an account was given of experiments on discharge delay in uniform fields for gap lengths up to a few cm. The present paper gives similar results for non-uniform fields. The electrodes employed were (1) pointed anode, plane kathode, (2) plane anode, pointed kathode and (3) pointed anode, pointed kathode. The surge voltage characteristics for these three cases were compared with that for a sphere gap. The change from the canal type of discharge to the arc discharge, with positive point and negative plane, is accompanied by a predischarge which is propagated from anode to kathode with a velocity of several thousand km. per sec. The velocity of propagation of the ensuing main discharge is one order of magnitude higher. With negative point electrode a predischarge starts both from the point and from the plane, both discharges having about the same velocity as the main discharge when the point is positive. A. W.

**828. Effect of Positive Ions on Ignition of the Column of a Gas Discharge. M. Steenbeck.** *Wiss. Veröff. a.d. Siemens-Werken,* 15. 3. *pp.* 32–41, 1936.—In the ignition of the column of a vacuum discharge the field distortion due to positive ions has a favourable effect on the subsequent ignition phenomena, similar to what is found in the case of spark or glow discharges, though the mechanism is quite different. The electron temperatures which are necessary for ignition to take place can be calculated. The ignition field-strengths in Hg vapour are about the same as the discharge field-strengths in a tube of 20 times smaller diameter. Very small space-charges, of the order of $10^8$ ions for each cm. of the length of the column, are sufficient to cause extensive breakdown of the ignition field-strengths. A. W.

**829. Field-Strength along Positive Column in Hg Vapour for Very Small Current Densities. G. Mierdel and W. Schmalenberg.** *Wiss. Veröff. a.d. Siemens-Werken,* 15. 3. *pp.* 60–74, 1936.—Measurements were made of the field-strengths along the positive column of a glow discharge in saturated Hg vapour, as dependent on the pressure between 0·76 and 17 tor. and on the current density down to $10^{-6}$A/cm.$^2$. The results obtained for these low current densities give a falling characteristic. Theoretical considerations show that this falling characteristic cannot be explained by either temperature effects, multiple impacts or by the effects of microfields. It appears much more probable that the cause is to be sought in the lack of field-forming carriers, the conditions for quasineutrality not being satisfied. A. W.

**830. Time-Lag in a Glow Discharge. R. Schade.** *Zeits. f. techn. Physik,* 17. 11. *pp.* 391–393, 1936. *Phys. Zeits.* 39. *pp.* 817–819, *Dec.* 1, 1936.—Theoretical and experimental observations have been made on the time-lag in the starting of a glow discharge in Ne, with special reference to the dependence on temperature, starting current and starting overvoltage. Curves are given showing these variations over a large range of conditions, with time-lags varying from $10^{-5}$ to 1 sec. Formulæ which fit the experimental data are deduced for the variation with starting current and overvoltage. J. E. R.

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**831. Kathode Fall in the Glow Discharge. Part I. A. Gehrts.** *Zeits. f. techn. Physik,* 17. 11. *pp.* 393–396, 1936. *Phys. Zeits.* 37. *pp.* 819–822, *Dec.* 1, 1936.—Previous investigations have shown that a consideration of the kathode fall as a double space-charge layer is impossible in the study of the discharge processes in hot kathode and Hg rectifiers. Similar considerations are applied to the case of the glow discharge. Experimental work has shown that the field strength in the kathode-fall space is proportional to the distance from the plasma kathode region limit. From these considerations it follows that positive ions in the kathode-fall space cannot fall freely, and that numerous collisions take place between the ions and neutral gas molecules. These collisions must be inelastic and the ion production in the kathode-fall space is concentrated in the region near the limit of the plasma kathode layer. J. E. R.

**832. Normal Kathode Fall in Hydrogen and Deuterium. A. Güntherschulze and H. Schnitger.** *Zeits. f. Physik,* 103. 7–8. *pp.* 491–494, 1936.—Apparatus is described in which $H_2$ or $D_2$ can be introduced into a discharge tube at will and measurements made on the discharge under strictly comparable conditions. Owing to the difference in ionic mass in the two cases, changes are noted in all the usual discharge constants. The normal kathode fall, $V_n$, is 9·3 % greater, and the normal current density $i_n$ 36·7 % less in $D_2$ than in $H_2$. The optically measured kathode fall space, $d_n$, is 22·1 %, and $d_a$, the length of the anode glow is 12·1 % greater in $D_2$. J. E. R.

**833. Effect of Excited Gases on Processes Occurring in the Kathode Region of Glow Discharges. E. Reichrudel and G. Spiwak.** *Phys. Zeits. d. Sowjetunion,* 10. 2. *pp.* 121–141, 1936. *In German.*—The effect of metastable gas atoms on the appearance of the kathode region in a glow discharge in Ne (containing a little A) at pressures of 0·2 to 1·5 mm. and discharge currents of $10^{-4}$ to $10^{-5}$ A is examined. The presence of the excited atoms causes a reduction in the kathode fall of potential; the effect increases on reduction of the discharge current. The current density increases with reduction in the work function of the kathode. The excited atoms contribute to the volume and surface ionisation and in the kathode region the volume effect is greater than the surface effect if the field is large enough for the formation and maintenance of a discharge. The concentration of the metastable atoms is different in different parts of the kathode region and the maximum concentration occurs in the negative glow. H. J. H. S.

**834. Probe Measurements in a Low-Pressure Mercury Discharge. W. Denecke.** *Ann. d. Physik,* 27. 7. *pp.* 597–621, *Dec.,* 1936.—The author describes a discharge tube suitable for such measurements, and gives a discussion of the method, in particular of the influence of the finite length of the probe and of the influence of surface charges collecting on the glass capillary insulating the probe and on the wall. Reliable values of the electron temperature can only be obtained with long probes. It is shown how the space potential and the electron density can be found. In a similar way the density of positive ions is determined. It is 3–5 times greater than the electron density. This difference is attributed to the presence of negative ions. R. P.

**835. Vacuum Carbon Arc. F. H. Newman.** *Phil. Mag.* 23. *pp.* 181–186, *Jan.,* 1937.—An arc was started between electrodes of pure C (graphite 99·98 %) in a pyrex tube containing air or $H_2$ at pressures ranging from 1 to 0·01 mm. of Hg. The arc was started by passing a momentary electrical discharge between one of the C electrodes and a third electrode, a steady p.d. of 100 V being applied to the C electrodes. In other experiments the arc was started by an electrical discharge perpendicularly across the space between the two C electrodes, or by application of an electrodeless discharge. In all cases the auxiliary discharge was passed for less than a second and in no case was there any heating of the C electrodes. Spectrograms of the arc taken at the moment of starting show only the lines of the residual gases in the discharge tube. The results generally indicate that though thermionic emission may be responsible for the maintenance of an arc between hot C electrodes, it does not enter into the mechanism of the striking of arcs in vacua, the arc under such conditions being started by a rapid surge of positive ions to form the positive ion space charge at the kathode. A. W.

**836. Negative Ion Formation. Parts II and III. F. L. Arnot.** *Roy. Soc., Proc.* 158*A*. *pp*. 137–166, *Jan*. 1, 1937.—In Part I of this series [see Abstract 4820 (1936)] it was shown that negative ions were produced in Hg vapour by a new process of formation. Part II is an extension of this work to $H_2$, $N_2$, $O_2$ and $CO_2$. Only monatomic negative ions were found in $H_2$ and $N_2$. Oxygen gave diatomic as well as monatomic negative ions. $CO_2$ gave $CO_2^-$, $CO^-$, $O_2^-$, $O^-$, and $C^-$. It is shown that all of these ions, like those of Hg, are produced by the new process of formation in which positive ions acquire two electrons from any negatively charged surface, including the filament, to which they are driven. Any negative ions produced by the processes which have been presumed in the past to form negative ions were too few to be detected. The probability of conversion of positive ions into negative ions increases with the kinetic energy, and with the atomic number of the positive ion. For positive ions of 180 V energy the probability of conversion in all of the above gases has values between $10^{-5}$ and $10^{-3}$, depending upon the negative ion formed. In Part III the energy distribution of positive ions rebounding as negative ions from a Ni surface has been measured for the ions formed in $H_2$, $N_2$, $O_2$ and $CO_2$. The negative ions come off the surface on which they are formed with a wide range of energy, extending from zero to beyond 60 V for $O^-$ and beyond 109 V for $H^-$ when the parent positive ions strike the surface with an energy of 200 V. This provides a new and far more informative method than has been previously used of obtaining accommodation coefficients for positive ions. The results show that, for the positive ions formed in each gas, the accommodation coefficient for ions of a particular energy has a wide range of values amongst which there is always one, and sometimes two, most probable values. AUTHORS.

**837. Excitation of Mercury by Collision of Slow Positive Mercury Ions. Heinz Moser.** *Ann. d. Physik*. 28. 1. *pp*. 97–103, *Jan*., 1937.—The excitation functions of the Hg lines 2537 and 3125 Å by positive Hg ions up to 5000 V are shown to differ in character from the corresponding functions for excitation by electrons. At low voltages the excitation curves are flat, becoming steeper and then flatter again with increasing voltage. Excitation by positive ions also gives an intensity distribution in the spectrum which differs from that for excitation with electrons, the resonance line appearing particularly strongly in the former case. As is observed for excitation by electrons, positive ions of low voltage bring out the triplet lines more strongly than the singlet lines, whereas at higher voltages the reverse is true. Observation of the Doppler effect for the

resonance line shows that the emission resulting from positive ion collision is partly from particles at rest and partly from particles in motion.
L. A. W.

***838. Electric and Magnetic Focusing in Mass Spectroscopy. A. J. Dempster.** *Phys. Rev.* 51. *pp.* 67–69, *Jan.* 15, 1937.—The theory of a mass spectrograph is described. The instrument is arranged so that an electric field forms near the entrance to the magnetic field a real image of the entrance slit with rays of one velocity. The velocity dispersion produced by the electric field is counter-balanced by the velocity dispersion in the magnetic field. Author.

**839. Oxidation of Selenium in the Glow Discharge. E. Olson and V. W. Meloche.** *Am. Chem. Soc., J.* 58. *pp.* 2511–2516, *Dec.*, 1936.—In the reaction between Se and $O_2$ in the glow discharge, the effects of the variables, pressure, current, electrode distance, shape of tubes, are studied. Optimum conditions for the production of $SeO_2$ and $SeO_3$ are ascertained. The characterisation of these products, by means of chemical analysis, is supplemented by X-ray diffraction studies. The reaction is best initiated in the negative glow and is completed by the deposition of product on the cold tube walls. Banded deposits of Se metal and oxide were obtained in the glow discharge column. This afforded a means of determining the region in which the oxidation of Se takes place. A correlation of voltage measurements and the character of the striated deposits shows that vaporisation and activation of Se takes place in the luminous regions. Combination with $O_2$ takes place in the dark regions. After considering the experimental facts, a mechanism is suggested. Authors.

**840. Equilibrium $2H_2 + O_2 \rightleftarrows 2H_2O$ in Glow Discharge. A. Güntherschulze and H. Schnitger.** *Zeits. f. Physik*, 103. 9–10. *pp.* 627–632, 1936.—In the kathode parts of the glow discharge in water vapour at low pressures large quantities of oxy-hydrogen gas are formed. The equilibrium $2H_2 + O_2 \rightleftarrows 2H_2O$ behaves as though the kathode part of the glow discharge acts as a catalysing agent, whose temperature rises from 1900° to 2800° Abs. when the water vapour pressure is increased from $4 \times 10^{-2}$ up to 20 tor. In order to reach this equilibrium a time of one to two hours is necessary with normal current density of the glow discharge in the discharge vessel employed, which had a capacity of 17 l.
A. W.

**841. Registration of Coincidences with Two Geiger-Müller Counters. J. Starkiewicz.** *Acta Physica Polonica*, 4. 4. *pp.* 447–461, 1935. *In French.*—The effect of alterations in the components of the amplifying circuit and in the construction and arrangement of the counters themselves, on the number of coincidences recorded by Geiger-Müller counters is examined.
F. C. C.

***842. Sensitivity of Tube Counters. Robley D. Evans and R. A. Mugele.** *Rev. Sci. Instruments*, 7. *pp.* 441–449, *Dec.*, 1936.—The useful sensitivity S of a tube counter exposed to feeble $\gamma$-rays is proportional to $(N - B)/(N + B)^{1/2}$, where B is the background counting rate and N is the counting rate when the $\gamma$-ray source is present. The sensitivity may be increased by using kathodes of high atomic number and in the form of grids or grooved tubes of greater effective area than solid smooth kathodes. If the kathode is not radioactive, various cleaning treatments do not increase its sensitivity. Temperature changes between 0° and 45° C. do not appreciably affect the copper kathode tube counter. For a counter

12 cm. long and 2 cm. in dia. maximum sensitivity is obtained with a 100-mesh copper-gauze kathode when the counter contains air at 6·5 cm. Hg pressure and is operated 170 V above threshold. The high sensitivity of the $\gamma$-ray counters permits the direct measurement of the feeble $\gamma$-rays from the radioactive impurities in ordinary granitic rocks, and when combined with independent measurements of the U content by the Ra method leads to Th measurements having a probable statistical error of about $12 \times 10^{-7}$ gm. Th per gm. rock when only 2 hr. of measurements are made on 1400 gm. of rock. F. C. C.

***843. Tube Counters and Coincidence Theory. Part II. L. Jánossy.** *Zeits. f. Physik,* 104. 1–2. *pp.* 68–80, 1936.—Continuing previous work [see Abstracts 2337 and 4166 (1936)] the theory is generalised to predict the behaviour of tube counters arranged for coincidences and exposed to radiation having an asymmetrical azimuthal orientation. F. C. C.

***844. Continuously Acting Cloud Chamber. H. Brinkman.** *K. Akad. Amsterdam, Proc.* 39. 10. *pp.* 1185–1186, 1936.—A brief description is given of a chamber in which up to 20 expansions per sec. can be obtained. D. H. F.

***845. D.C. Production at High Voltage. A. Piekara.** *Acta Physica Polonica,* 4. 4. *pp.* 345–354, 1935. *In French.*—A simple form of apparatus for producing a small h.v. direct current is described in which some 20 condensers of capacity 1 $\mu$ F are charged at a potential of 500 V and then connected in series by a rotating switch to furnish a supply at 10,000 V. To produce potentials of 1000 to 2000 V from potentials of half that value, one or more flashing neon lamps are arranged to set up oscillations in a circuit containing a triode and two diodes and are so adjusted as to connect a condenser charged to the supply potential in series with the supply potential itself. F. C. C.

***846. The Cyclotron. E. O. Lawrence and D. Cooksey.** *Phys. Rev.* 50. *pp.* 1131–1140, *Dec.* 15, 1936.—Significant improvements of the apparatus for the multiple acceleration of light ions, now called the "cyclotron," have recently been made. The apparatus produces many $\mu$A of deuterons having energies up to 6·3 eMV and a few tenths of 1 $\mu$A of 11 eMV doubly charged He ions. The means of deflecting the high speed ions from the accelerating system has also been improved, with the result that the ions can now be withdrawn completely from the apparatus into the air through a thin window in the chamber wall. The present paper is devoted to a detailed description of the cyclotron, including its adjustment and operation, with a discussion of the questions involved. AUTHORS.

**847. Impulse Circuits for Obtaining Time Separation between the Appearance of Potential at Different Points in a System. L. B. Snoddy, H. Trotter, Jr., W. T. Ham, Jr., and J. W. Beams.** *Frank. Inst., J.* 223. *pp.* 55–76, *Jan.*, 1937.—The acceleration of ions to high speeds by impulsive methods requires an electrical circuit capable of transferring potential from electrode to electrode of the accelerating tube at the proper rate. To be of practical value the circuit must be capable of operation with time delays between two successive points of the system as low as $2 - 3 \times 10^{-8}$ sec. and at voltages above 100 kV. An investigation of various methods suitable for this purpose is described, the methods being divided into the following groups: (1) transmission lines with continuously distributed constants, *i.e.*, real transmission lines; (2) transmission lines

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with constant lumped constants, *i.e.*, artificial transmission lines; (3) spark gap lines, and (4) discharge tube lines. A. W.

**848. Method of Direct Half-Logarithmic Registration by Characteristic Lines. P. K. Hermann.** *Zeits. f. techn. Physik*, 17. 11. *pp*. 482–487, 1936.—A method of measurement is described with the help of which the probe current-voltage characteristic lines of gas discharges are demonstrated and estimated with the Braun tubes in half-logarithmic scale of relation. Further the results of measurements are given, drawn from the investigation of the relations to the screens of Hg vapour rectifiers, and which indicate that the p.d. which exists over long narrow gaps in the screens is greater than the difference of the burning voltage which is produced by the putting-in of the screen. The kinks in the probe characteristic lines which are found on the probes at the entrance and exit from narrow gaps in the screens are brought into connection with the space charges arising at these places. The influence of magnetic fields consists in a raising of the potential gradients over the gap in the screen, in an increase of the anomalies of the probe characteristic lines at strongly loaded screen gaps, and in the possibility of causing a starting of oscillations under practical conditions, under which without magnetic field no oscillations would set in. [See Abstract 4819 (1936).] J. J. S.

*See also* Abstracts 587, 662, 668, 672, 698, 706, 778, 892, 928.

## CONDUCTION IN SOLIDS AND LIQUIDS.

**849. Contribution to the Electrical Resistance of Metals from Collisions between Electrons. W. G. Baber.** *Roy. Soc., Proc.* 158*A*. *pp*. 383–396, *Jan*. 15, 1937.—The contribution to the electrical resistance of metals from collisions between the conduction electrons is discussed. It is shown that these collisions contribute an extra term proportional to $T^2$. This term is shown to be negligibly small for normal metals down to less than 1° K., but for the transition metals Pd and Pt it is the predominating term at He temperatures, in agreement with experiment. AUTHOR.

***850. Valve Microammeter. A. W. Vance.** *Rev. Sci. Instruments*, 7. *pp*. 489–493, *Dec*., 1936.—A d.c. amplifier of high gain and with an odd number of stages, has its output connected in series with its input. The output and input are therefore in opposition and the amplifier locks in an equilibrium condition. A change of input voltage then produces an almost equal change of output voltage, and the input and output currents corresponding to these voltages are therefore in the same ratio as the input and output resistances, which ratio may be adjusted at will. The arrangement is therefore a current amplifier, and very small input currents may be measured in terms of much larger output currents, the values of which are indicated by a comparatively robust instrument. A self-contained instrument containing three stages of amplification has a range of $10^{-8}$ to $10^{-2}$ A, full scale; voltage, 0·1 or 1 V. L. H.

**851. Average Electric Resistance and Duration of Collision between Two Metallic Bodies. L. Rebuffé.** *Comptes Rendus*, 203. *pp*. 1230–1232, *Dec*. 7, 1936.—A spherical ball of steel or one elongated with spherical cap (mass *m*, radius of curvature *r*) suspended by a Cu wire, forms the bob of a pendulum. This is connected through the wire, a source of e.m.f.(E), a resistance R, and a ballistic galvanometer, with a metal plate against which the bob strikes, thus completing the circuit.

If $\rho$ be the average resistance of the contact and $\tau$ the duration of a collision, experiments show that $\rho$ varies with the metal of the plate, $m$ and $r$, and increases, but not linearly with the velocity of the collision ($v$); $\tau$ is proportional to $(m^2/r)^{1/5}$ and also to $(1/v)^{1/5}$ for very hard metals; it is independent of the form of the bob provided $m$ and $r$ are the same. $\rho\tau$ is approximately constant for all metals, and definitely so for the same metal. It is suggested that the resistance is due to the current passing through a thin layer of air retained by viscosity between the colliding bob and plate. **Errata,** *ibid. p.* 1408, *Dec.* 14, 1936. C. A. S.

**852. Semi-Conductors with Artificial Blocking-Layers. W. Hartmann.** *Zeits. f. techn. Physik.* 17. 11. *pp.* 436–439, 1936. *Phys. Zeits.* 37. *pp.* 862–865, *Dec.* 1, 1936.—Observations on the rectifying action of ZnO using an artificial blocking-layer (*e.g.*, a film of shellac) are compared with similar observations on $Cu_2O$, and it is shown that ZnO belongs to the class of semi-conductors whose conductivity decreases with increase of O content, unlike $Cu_2O$, whose conductivity increases with increase of O content. A pronounced rectifying action is found with ZnO, the direction being opposite to that in $Cu_2O$. D. H. F.

**853. Constitution of the "Barrier Layer" in the Copper-Oxide Rectifier. F. Waibel.** *Wiss. Veröff. a.d. Siemens Werken,* 15. 3. *pp.* 75–86, 1936.—The processes which take place in the barrier layer of a copper-oxide rectifier are investigated experimentally. The construction of such a rectifier with an oxide layer of the unusual thickness of 0·3 mm. is described, and its properties investigated layer by layer between the limits of 35 to 300 $\mu$. Current-voltage characteristics are obtained for each layer and curves given showing the relationship between specific resistance and thickness and between resistance and voltage for a voltage range from − 400 to + 400 V. The specific resistance falls from $10^{12}$ ohms/cm. at thickness 300 $\mu$ to $10^9$ ohms/cm. at 50 $\mu$, following an exponential law. All the curves show that the rectification powers of the layers vary with voltage from 100 volts upwards. An explanation of the results in terms of the effects of field strength is suggested, the limiting field strength being $1{\cdot}5 \times 10^4$ V/cm. The bearing of the results on commercial rectifiers and crystal detectors is briefly discussed. J. E. R.

**854. Magnetic Properties of Supraconducting Metals and Alloys. L. W. Schubnikow, W. I. Chotkewitsch, J. D. Schepelew and J. N. Rjabinin.** *Phys. Zeits. d. Sowjetunion,* 10. 2. *pp.* 165–192, 1936. *In German.*—In experiments made on Pb, Hg and alloys of Pb-Tl, Pb-Bi, Pb-In and Hg-Cd, it was found that with the alloys, even a small amount (2–8 %) of one of the constituents caused an increase in the field required to destroy the supraconducting property. Up to the critical field $H_{k1}$ the permeability is zero in the alloys $PbTl_2$ and PbBi, and on further increasing the field to the critical value $H_{k2}$, the permeability increases to unity. An increase of the content of one constituent of an alloy causes an increase in the difference $H_{k2} - H_{k1}$ in which $H_{k2}$ increases and $H_{k1}$ diminishes. The critical current $K_j$ necessary to destroy supraconductivity in wires made from the alloys is proportional to the dia. of the wire, and the field due to this current, $H_{kj}$ is always about 65 % of the value of $H_{k1}$. G. E. A.

**855. Critical Values of Field and Current for Supraconductivity of Tin. L. W. Schubnikow and W. I. Chotkewitsch.** *Phys. Zeits. d. Sowjetunion,* 10. 2. *pp.* 231–241, 1936. *In German.*—A small coil of 700 turns, 11 mm. long and 8 mm. dia. is joined to a ballistic galvanometer and moved at the centre of a ring of tin to determine the value of the magnetic field there; the external field is produced by a solenoid and the temperature is 2·625° Abs. If the field due to the current in the tin reaches the critical value at any point on the surface of the ring or, if the tangential component of the applied field reaches the critical value $H_k$, the supraconductivity is destroyed. Further, when the sum of the tangential component of the applied field and the field due to the current reaches the critical value, the same effect is produced. H. M. B.

**856. Electrical Resistivity of Single Crystals of Dilute Solid Solutions in Zinc. H. E. Way.** *Phys. Rev.* 50. *pp.* 1181–1185, *Dec.* 15, 1936.—Sets of single crystals were grown of binary alloys consisting of dilute solid solutions of Cd, Cu, Ag, Au, Ni and Fe, each in zinc. Electrical resistivities at 20° C. are expressed in terms of principal resistivities, $\rho_0$ and $\rho_{90}$, these values coming from the usual $\cos^2 \theta$ ($\theta$ = orientation) plot of measured resistivities of a set of crystals. The resistance increases in a given series of alloys with increasing concentration, in a nonlinear fashion. The initial increase in resistivity (above that of pure zinc) in micro ohm-cm. per atomic % of solute is: Cd 0·94, Cu 0·4, Ag 1·1, Au 2·3, Ni 51·0, Fe 300·0. This is correlated with the nearness of the solute metal to zinc in the periodic table. The ratio of principal resistivities is slightly higher than that for the zinc crystal. Temperature coefficients decrease in such a way that Mathiessen's rule is satisfied (with a maximum deviation of 4 %) for all the alloys. AUTHOR.

**857. Resistance of Palladium and Palladium-Gold Alloys. J. G. G. Conybeare.** *Phys. Soc., Proc.* 49. *pp.* 29–37, *Jan* .1, 1937.—Measurements of the electrical resistances of Pd and four alloys of Pd and Au are made from liquid-oxygen temperature to about 1000° C. It is found that the variation of resistance with temperature for these alloys resembles that of constantan for compositions up to about 60 atoms % of Au, where there is a change over to the normal type of resistance curve. This, and the results for pure Pd, are shown to be in agreement with the quantum-mechanical theory of conductivity as applied by Mott to the transition metals. AUTHOR.

**858. Conductivity of Acids and Salts in Liquid Ammonia. E. N. Gurjanowa and W. A. Pleskow.** *Acta Physicochimica,* 5. 4. *pp.* 509–536, 1936. *In German.*—The conductivity of a number of acids and salts dissolved in liquid $NH_3$ is determined. The determinations are carried out at − 40° C., and at dilutions up to 100,000 l./mol. The results indicate that the Debye-Onsager theory in its classical form is not applicable to electrolytic solutions in liquid $NH_3$. F. J. B.

**859. Conductance of Aqueous Solutions as a Function of Concentration. Part II. Potassium Ferrocyanide. G. Jones and F. C. Jelen.** *Am. Chem. Soc., J.* 58. *pp.* 2561–2565, *Dec.,* 1936.—The conductance of potassium ferrocyanide solutions is determined at 25 and at 0° from great dilution up to nearly saturation. The data are used to test various equations which have been proposed to express the conductance as a function of the concentration. [For Part I see Abstract 2157 (1934).] AUTHORS.

**860. Resistance and Capacity Behaviour of Strong Electrolytes in Dilute Aqueous Solution. Part I. O. M. Arnold and J. W. Williams.** *Am. Chem. Soc., J.* 58. *pp.* 2613–2616, *Dec.,* 1936.—A method is described which serves for the simultaneous observation of electrical conductance and dielectric constant of very dilute electrolyte solutions at high radio frequencies. The apparatus is of the comparator-resonance type. It consists of three distinct units, a variable high frequency oscillator circuit, an intermediate circuit and a comparator circuit with thermocouple-galvanometer measuring system. The mathematical theory of the circuits is considered. Dielectric constant change is calculated from a comparison of the resonance settings of the standard variable precision condenser in the comparator circuit with the conductance cell connected and disconnected. For the evaluation of electrical conductance change there are required observations of the comparator circuit galvanometer deflections, again at resonance and with the cell connected and disconnected. It is further pointed out that the method developed may be applied to the measurement of l.f. currents through other types of resistances. [See following Abstract.] AUTHORS.

**861. Resistance and Capacity Behaviour of Strong Electrolytes in Dilute Aqueous Solution. Part II. O. M. Arnold and J. W. Williams.** *Am. Chem. Soc., J.* 58. *pp.* 2616–2624, *Dec.*, 1936.—A quantitative experimental study is made of the dispersions of the electrical conductance for strong electrolytes of several valence types in extremely dilute aqueous solutions. The conductance of these solutions is observed at frequencies corresponding to the seven wave-lengths, 15, 30, 50, 75, 100, 130 and 170 m. In addition, observations are made at the frequency 1000 ∼. The results of the experiments are compared with the requirements of the dispersion theory. They are found to be in satisfactory agreement, indicating once more that probably the purely physical interionic attraction theory adequately explains and describes the behaviour of an ideal electrolyte. [See preceding Abstract.] AUTHORS.

**862. Preparation of High-Grade Conductivity Water. P. A. Thiessen and K. Herrmann.** *Zeits. f. Elektrochem.* 43. *pp.* 66–69, *Jan.*, 1937.—Ordinary conductivity water ($\kappa = 1{\cdot}5$ to $2 \times 10^{-6}\,\Omega^{-1}$) is prepared by distillation in the presence of $KMnO_4 + H_2SO_4$, then redistillation with $Ba(OH)_2$. This is freed from $CO_2$ by heating at 80–90° C. for 20–30 hr. in a Jena flask, while a stream of purified $N_2$ is passed in and precautions taken to avoid entry of $CO_2$ from the laboratory atmosphere. By closing a tap the pressure of the entering $N_2$ is used to lift the degasified water into a quartz flask from which it is distilled directly into the conductivity cell of Jena glass, the $N_2$ stream being meanwhile continued. Glass and $SiO_2$ are purified with ($H_2SO_4 + K_2Cr_2O_7$) washed for many days and steamed for 40hr. at least. It is important to prevent water being carried over mechanically by the steam, to avoid this the neck of the distilling flask is heated electrically by a collar. The yield of the apparatus is 400 ml./hr. with $\kappa_{25^\circ C} = 6{\cdot}5$ to $8 \times 10^{-8}\,\Omega^{-1}$. With this water conductivity measurements at *N*/100,000 are possible. Owing to absorption effects at the Pt electrodes further dilution is impracticable. By adding a third stage to the apparatus water is obtained with $\kappa = 5{\cdot}95 \times 10^{-8}\,\Omega^{-1}$ against 5·8 found by Kohlrausch after 42 distillations and a theoretical value of 5·52. The cost of the apparatus (at par) is about £7. 10*s*. D. R. H.

**863. Electric Conduction in Dielectric Liquids Ionised by X-Rays. I. Adamczewski.** *Acta Physica Polonica*, 4. 4. *pp.* 427–433, 1935. *In German.*—In continuation of earlier work [see Abstract 1819 (1935)], the current produced by X-rays in saturated hydrocarbons is measured in dependence on the potential and the electrode distance.

The law describing this dependence contains essentially three constants. These vary systematically throughout the series of saturated hydrocarbons. R. P.

**864. Conductivity of Solid Dielectrics at High Field-Strengths. A. Walther and Lydia Inge.** *Techn. Phys., U.S.S.R.* 3. 8. *pp.* 700–714, 1936. *In German.*—The d.c. conductivity of rock-salt and glass is measured at field-strengths up to 2000 kV/cm. The conductivity is increased as much as tenfold at high field-strengths. From the conductivity-temperature relation at high stresses, it is concluded that the increase of conductivity with field-strength is largely due to an increase in ionic conductivity. Breakdown at room-temperatures is shown to be thermal as well as electric. E. R.

*See also* Abstracts 637, 779, 877, 880, 912.

## DIELECTRICS AND CAPACITANCE.

**865. Distribution of Relaxation Times in Typical Dielectrics. W. A. Yager.** *Physics,* 7. *pp.* 434–450, *Dec.,* 1936.—K. W. Wagner's treatment of the distribution of relaxation times in dielectrics is reviewed; the effect of the density of distribution upon the frequency variation of the dielectric constant and dielectric loss factor is discussed; and a graphical method of evaluating the constants of Wagner's equation from experimental data is described. These constants have been evaluated for a a number of typical dielectrics, and the frequency variations of the dielectric constant and dielectric loss factor as computed from Wagner's equations and from the simple equations for a single relaxation time are compared with the observed behaviour. The quantitative correlation obtained between Wagner's equations and the experimental data investigated is viewed as a confirmation of Wagner's theory of a statistical distribution of relaxation times in dielectrics. AUTHOR.

**866. Physical Constants of Mixtures. D. A. G. Bruggeman.** *Phys. Zeits.* 37. *pp.* 906–912, *Dec.* 15, 1936.—Lichtenecker's formulæ, expressing the physical constants (*e.g.*, dielectric constant and conductivity) of mixtures in terms of the constants of the separate constituents are examined for a number of types of mixtures, and are generally confirmed. E. R.

**867. H.F. Dielectric Constants of Solids and the Influence of Water of Crystallisation on Dielectric Constant. E. F. Burton and L. G. Turnbull.** *Roy. Soc., Proc.* 158*A. pp.* 182–198, *Jan.* 1, 1937.—The dielectric constants of sodium chloride, alum, magnesium sulphate (crystalline and dehydrated), copper sulphate (crystalline and dehydrated), potassium iodide, borax (crystalline and dehydrated), are measured at room-temperature. The method, using a resonance circuit at a frequency of $2 \times 10^6$ ∼, involved the determination of the dielectric constant of mixtures of the salt and water-free oil in different proportions. The dielectric constant of the salt is then calculated from the formula of Fricke, the dielectric constant of the oil being known. In the few cases where concordant results have been obtained by other investigators, such results are in good agreement with those reported here. It is pointed out that when a salt possessing water of crystallisation is dehydrated, its dielectric constant increases. It is seen that the change in molecular refractivity per molecule of water of crystallisation is approximately constant. AUTHORS.

**868. Dielectric Polarisation of *n*-Long Chain Ketones near their Melting Points. A. Müller.** *Roy. Soc., Proc.* 158*A*. *pp.* 403–414, *Jan.* 15, 1937.—The dielectric capacity of each of two symmetrical normal long chain ketones is measured at different temperatures near the melting point of the substance. Considerable increase of the dielectric constant is observed in a range of 15° to 20° C. below the melting points. The phenomenon is interpreted as an increase of rotational mobility of the chain molecules round the chain axes in a state where the substances are still solid. This confirms the conclusion previously drawn from structure analysis of similar substances near their melting points. An appreciable mutual influence of the dipoles is observed in the pure molten substances. Observations on dilute solutions yield a dipole moment which is identical with that found in acetone and similar ketones. AUTHOR.

**869. Dielectric Constants of Gases and Vapours. M. Kubo.** *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 663. *pp.* 238–243, *Dec.,* 1936. *In English.*—The dielectric constants of the vapour of 1,4-dioxane were measured and used to calculate the dipole moments at various temperatures. The moment found (0·43—0·49 D) can be accounted for by the presence of a polar form in molar percentage less than 5 %. This is in agreement with the results of electron diffraction investigation as well as of the Raman effect. [See Abstract 343 (1937).] AUTHOR.

**870. Measurement of Dielectric Constant at Very High Frequencies. W. I. Kalinin.** *Phys. Zeits. d. Sowjetunion,* 10. 2. *pp.* 257–259, 1936. *In German.*—A note on a variation of Drude's second method. Lecher wires pass through the specimen, and are closed at the far end by a thermal ammeter. A relation, a function of the apparatus, gives the dielectric constant in terms of the resonance-length of the conductors between the specimen and the ammeter. The "Lecher wires" are actually a tube and an axial rod. [See also Abstracts 2889 (1930) and 1653 (1933).] W. H. W.

**871. Dispersion Measurements at Short Wave-Lengths. M. Wien.** *Phys. Zeits.* 37. *pp.* 869–871, *Dec.* 1, 1936.—The results of v. Ardenne, Groos and Otterbein [see Abstract 4844 (1936)] are examined, and from them the wave-length $\lambda_s$, at which anomalous dispersion is most pronounced, is calculated for the various liquids. It is shown that $\lambda_s = \lambda\sqrt{(\epsilon_0 - \epsilon)/(\epsilon - n^2)}$, where $\epsilon$ is the dielectric constant measured at a wave-length $\lambda$, $\epsilon_0$ is the static dielectric constant and $n$ is the refractive index. In accordance with the simple dipole theory, $\lambda_s$ should be constant for all values of $\lambda$, and this is the case for ethyl and methyl alcohol and water, but not for nitrobenzene, glycerin and cane-sugar solutions. E. R.

**872. Dielectric Constants of Dilute Salt Solutions. W. M. Mazee.** *Phys. Zeits.* 37. *pp.* 914–916, *Dec.* 15, 1936.—The results of determinations of the dielectric constants of dilute solutions of certain salts namely, KI, $MgSO_4$, $BeSO_4$, $K_3Fe(CN)_6$, $K_4Fe(CN)_6$ and $Ba_2Fe(CN)_6$, are reported. Each substance was specially purified before being used. The method used for the determinations has been previously described [see Abstract 1809 (1935)]. Very low frequencies are employed which eliminates the uncertainty of the results obtained with high frequencies. The values found show close agreement with calculations based on the Debye-Falkenhagen equation. A. M. T.

**873. Dipole Moment of Tetrachloroethylene. Chao-Lun Tseng, Chun Liu and Cheng E. Sun.** *Chinese Chem. Soc., J.* 4. *pp.* 473–476, *Nov.*, 1936. *In English.*—The dipole moment of tetrachloroethylene is determined and found to be zero. AUTHORS.

**874. Application of the Raman-Krishnan Theory to Dipole Moment Measurements. H. O. Jenkins and S. H. Bauer.** *Am. Chem. Soc., J.* 58. *pp.* 2435–2438, *Dec.*, 1936.—Theoretical objections to the Raman-Krishnan theory of anisotropic dielectrics are raised. Empirical tests further indicate that the application of the above theory to dielectric constant measurements of dilute solutions of polar solutes in non-polar media would enable one to predict the difference between the moments as determined by the dilute solution method and those derived from gas measurements only as to order of magnitude. AUTHORS.

**875. Relaxation Time and Dipole Moment of Gliadin. S. Arrhenius.** *J. Chem. Phys.* 5. *pp.* 63–66, *Jan.*, 1937.—From measurements on three solutions of varying concentration of gliadin in alcohol, the mean dipole moment of gliadin is found to be $13 \cdot 5 \times 10^{-18}$ e.s.u., and the time of relaxation (for rotation of the molecule about the long axis) is $9 \times 10^{-8}$ sec. E. R.

**876. H.F. Loss and Quasi-Crystalline Structure of Liquid Dielectrics. P. Debye and W. Ramm.** *Ann. d. Physik,* 28. 1. *pp.* 28–34, *Jan.*, 1937.—For most dipole substances, the value of molecular polarisation is smaller for a liquid than for the vapour, and Debye has explained this in terms of a quasi-crystalline structure of liquids [see Abstract 1813 (1935)]. Orientation of the polar molecule is opposed by a local field acting on the molecule due to its neighbours. The mean molecular moment is now calculated when this opposing force is taken into account. E. R.

**877. Absolute Measurement of H.F. Dielectric Loss by Condenser-Thermometer. C. Schmelzer.** *Ann. d. Physik,* 28. 1. *pp.* 35–53, *Jan.*, 1937.—The paper commences with a comprehensive discussion of the condenser-thermometer method for the absolute measurement of dielectric loss in the case of liquid materials, where the absolute accuracy of the measurements is estimated as at least 5 %. The discontinuous wave-lengths are measured for abnormal dispersion in the cases of water, the lower alcohols and ethyl ether. The h.f. conductivity of salt dissolved in benzene is determined and its dependence on the field observed, an increase with growing frequency being observed. This phenomenon is explained as a kind of voltage dissociation effect. The large increase of the h.f. conductivity is ascribed to the dipole loss of the ionic pairs. H. H. Ho.

*See also* Abstracts 485, 860, 861, 864, 928.

## ELECTROCHEMISTRY.

**878. Activity Coefficient of Copper Sulphate in Aqueous Solution. F. E. W. Wetmore and A. R. Gordon.** *J. Chem. Phys.* 5. *pp.* 60–63, *Jan.*, 1937.—The e.m.f. of the cell Cu *two phase amalgam*/ $CuSO_4$/$Hg_2SO_4$, Hg is measured with solutions whose concentrations vary from 0·02 molal to saturation, and for temperatures from 15° C. to 45° C. From these measurements and from freezing point and calorimetric heat of dilution data, activity coefficients are calculated, and the value of E° for the cell is determined. The results are in reasonable agreement with those of Nielsen and Brown and of Getman, but are in definite disagreement with the results of Lebettre. **Authors.**

**879. Electrolysis of Ferrous Chloride, Bromide and Iodide, and of Ferric Chloride in Aqueous-Alcoholic Solution. C. Charmetant.** *Comptes Rendus*, 203. *pp.* 1345–1347, *Dec.* 14, 1936.—With 0·5-*M* solutions, c.d. 1–4 A /dm$^2$., and Pt electrodes FeCl$_2$ gives little or no free Cl, but with < 150 gm./l. EtOH mainly FeCl$_3$ with a little HCl and acetaldehyde, the proportion of FeCl$_3$ decreases as the concentration of EOtH increases to a minimum for 450 gm./l. EtOH and then increases. It also decreases as the c.d. increases. At the kathode at first Fe is deposited, then, as HCl spreads, H$_2$. With low concentration of EtOH the Fe is grey at first and then bright, with more it is blacker and less adherent. The yield after 4 hr. decreases from 92–96 % with 1 A./dm$^2$. to 45–50 with 4 A/dm$^2$, it also decreases with increased concentration of EtOH. With FeBr$_2$ only FeBr$_3$ is formed at the anode, and at the kathode the yield of Fe decreases little (98–88 %) with increased c.d., but the Fe contains 2–8 % oxide. With FeI$_2$ I is formed at the anode, and Fe (nearly 100 % yield) at the kathode but containing up to 13 % oxide. With FeCl$_3$ a little Cl is evolved with < 150 gm./l. EtOH, but only HCl and acetaldehyde are formed with more. At the kathode almost all the Fe forms FeCl$_2$, a little only (very pure but badly adherent) with a strong current and high concentration of EtOH, the maximum yield being 34·7 % with 700 gm./l. in 4 hr. with 4A/dm$^2$. C. A. S.

**880. Born Effect of Ionic Mobilities. J. J. Hermans.** *Zeits. f. Physik*, 104. 1–2. *pp.* 100–112, 1936.—The Born-effect of the first kind is discussed and shown to account for the mobility of an ion in a medium containing dipoles although making the ionic radius very small, but it is inapplicable to the motion of ions in an electrolyte if the potential round the ion is not spherically symmetrical. The Born-effect of the second kind is applied to cases of unsymmetrical potentials both in weak and strong solutions and the formula obtained is in good agreement with Walden's rule, although deviations are seen for certain solvents, especially water. As some of the terms of the formula are not known exactly, a quantitative proof cannot be made. H. M. B.

**881. Absolute Interface Potential at an Electrode. M. Calvin.** *Manchester Phil. Soc., Mem.* 80. *pp.* 29–32, 1935–1936.—The paper is a mathematical development of a method for calculating the absolute interface potential at an electrode, based upon quantum mechanical considerations, and by considering the reactions with respect to a standard metal. J. F. B.

**882. Solution Potentials of Aluminium and Light Alloys. P. Lacombe and G. Chaudron.** *Rev. de Mét.* 33. *pp.* 697–704, *Dec.*, 1936.—The potentials of solution of Al and a number of light alloys are determined. The metals used included duralumin, anticorodal, alpax, Mg, Zn, together with some pure metals. The effects of annealing on the solution potential is determined at temperatures ranging from 190° to 550° C. The object of the investigation is to obtain data to enable the e.m.f. of different combinations to be calculated, and so avoid those which form dangerous couples. F. J. B.

**883. Potential of Iron in Hydrochloric Acid. L. Guitton.** *Comptes Rendus*, 203. *pp.* 1254–1257, *Dec.* 7, 1936.—The potential of Fe (a commercial product containing 0·1 % C and 0·4 % other impurities) against the calomel electrode was plotted against concentration of HCl

($N/10^6 - 10N$) after immersion for periods of 1 sec.—8 min. The curves obtained show that in very dilute solutions Fe is at first electropositive by reason of electronic or ionic inertia, and that in more concentrated solutions it adsorbs H-ions, and for concentrations above a certain limit acts as a H-electrode. [See Abstract 371 (1933).] C. A. S.

**884. Passive State of Chromium. E. Müller and V. Čupr.** *Zeits. f. Elektrochem.* 43. *pp.* 42–52, *Jan.*, 1937.—The active and passive states of Cr are studied, and the results recorded by an automatic recorder. Passive Cr is rendered active by kathodic polarisation and active Cr is rendered passive by anodic polarisation. The influence of the anions present upon the potential of activating and passivating is determined. The results are considered to be in support of the theory of the double layer previously given by the authors. F. J. B.

**885. X-Ray Structural Determination of Complex Ions in Electrolytic Solutions. W. Danilow, W. Finkelstein and M. Lewaschewitsch.** *Phys. Zeits. d. Sowjetunion*, 10. 2. *pp.* 223–230, 1936. *In German.*—Intensity curves are given for aqueous solutions of $K_2ZnI_4$, $K_2HgI_4$, $ZnI_2$. The last named can be explained by the presence of ions of $ZnI_4^{--}$. Inter-ionic distances in the complexes are different for $Zn^{2+}$ and $Hg^{2+}$. F. I. G. R.

*See also* Abstract 863.

## ELECTRONS, POSITRONS AND PROTONS, INCLUDING APPLICATIONS.

**886. Electron Diffraction Study of Bromochloroform. P. Capron and M. de Hemptinne.** *Ann. Soc. Sci. de Bruxelles*, 56. *pp.* 342–348, *Dec.* 23, 1936.—$BrCCl_3$, prepared by repeatedly passing a mixture of $Br_2$ and $CHCl_3$ over heated pumice stone until no further HBr is evolved, is examined by electron diffraction, and the principal interatomic distances determined by Pauling's radial distribution method. The pronounced maximum, unaffected by variations in intensity measurements, observed at 2·98 Å. is attributed to the Cl – Cl and Cl – Br spacings. It is shown that the results may be explained by assuming the interatomic distances to be (1) $C - Br = 2{\cdot}01$; $Br - Cl = 3{\cdot}00$; $C - Cl = 1{\cdot}76$; $Cl - Cl = 2{\cdot}95$ Å. or (2) $C - Br = 1{\cdot}86$; $Br - Cl = 3{\cdot}00$; $C - Cl = 1{\cdot}81$; $Cl - Cl = 2{\cdot}95$ Å. By chemical analogy with $CCl_4$, $CHCl_3$, $CH_2Cl_2$ and $CHBr_3$ it is concluded that the first set of interatomic distances is the more probable. A. G. Q.

**887. Effect of Submicroscopic Roughness of Metal Surfaces upon Electron Diffraction Patterns. F. Kirchner.** *Ann. d. Physik*, 28. 1. *pp.* 21–27, *Jan.*, 1937.—The author gives in detail his objections to the diffuse halo patterns afforded by polished metal surfaces being regarded as proof of the existence of an amorphous Beilby layer. It is pointed out that the sharpness of the diffractions obtained when an electron beam falls at grazing incidence on a surface is determined by the height of the projecting crystallites above the general level of the surface. During the polishing process this height will be reduced and the pattern rings correspondingly broadened. With a sufficiently smooth surface refraction will lead to a further broadening, and it is concluded that diffuse haloes are evidence of an extremely smooth surface rather than of an amorphous layer. A. G. Q.

**888. Correlation of the Secondary Emission of Electrodes Possessing Photo-Sensitivity and the Thermoeffect of Ions. A. Dobroliubsky.** *Phys. Zeits. d. Sowjetunion.* 10. 2. *pp.* 242–244, 1936. *In English.*—When electrodes of the type Cs-Cs$_2$O-Ag are bombarded by electrons the secondary emission is due to u.v. sensitivity; when there is an additional outgassing of the layer, the photo-sensitivity increases with time but the secondary emission shows a maximum. By using pencils of bombarding electrons of varying compactness, it is shown that the saturation of the secondary emission is not due to the destruction of the spatial charge, but to electrons drawn through the Cs$_2$O layer. The experiments and results are more complicated when the layer is heated.
H. M. B.

**889. Velocity Distribution of Electrons in a High Vacuum under the Influence of a Magnetic Field. I. M. Wigdortschik.** *Phys. Zeits. d. Sowjetunion,* 10. 2. *pp.* 245–250, 1936. *In German.*—A high vacuum discharge tube previously described [see Abstract 1296 (1935)]. is modified to investigate the velocity distribution of electrons from a hot kathode reaching a third electrode under the action of a magnetic field. The anode is cylindrical, surrounding the straight wire kathode, and the probe electrode consists of discs near the ends of the anode. The magnetic field is along the axis of the tube. It is shown that a negative potential $V_{max}$ on the third electrode is required to prevent a current flowing to this electrode, under given magnetic field and anode potential conditions. For probe potentials lower than the kathode potential it is shown that $\log i_g \propto V_g$. The variations of $V_{max}$ with magnetic field, anode potential and filament temperature are investigated. A short theoretical interpretation of the results is suggested. J. E. R.

**890. Velocity and Energy Distribution of Corpuscular Rays. R. Kollath.** *Ann. d. Physik,* 27. 8. *pp.* 721–741, *Dec.,* 1936.—For experiments on the velocity or energy distribution of corpuscular rays, involving the use of a Faraday cylinder of fixed aperture, it is shown that in 40 out of 50 published papers examined, the velocity or energy spectrum has been incorrectly deduced from the experimentally measured quantities. A table is given for converting experimental data obtained from (*a*) accelerating electric field, (*b*) transverse magnetic field with either constant or variable field, (*c*) transverse electric field, into correct ordinates anf abscissæ. The results of some 10 papers by different workers are corrected and in some instances the deduction of important conclusions such as an apparent vindication of a quantum over a classical treatment are shown to be unwarranted. F. C. C.

**891. Cross-Sections of Cl$_2$ and N$_2$ for Slow Electrons. J. B. Fisk.** *Phys. Rev.* 51. *pp.* 25–28, *Jan.* 1, 1937.—Measurements of total cross-section for collision of slow electrons between 2 and 40 V have been carried out in N$_2$ and Cl$_2$ by use of a Brode type apparatus. The results for N$_2$ compare well with those of previous investigators and with the theory of elastic scattering. The cross-section of Cl$_2$ is of order 2000 sq. atomic units with a maximum at $2{\cdot}65\ \sqrt{V}$, the curve being similar to those for Na, K, Cs and Rb. Application of the theory of elastic scattering indicates that only a small portion of these collisions can be elastic.
AUTHOR.

**892. Anomalous Charge Transfer Phenomena with Very Slow Canal Rays. F. Wolf.** *Zeits. f. techn. Physik,* 17. 11. *pp.* 428–429, 1936. *Phys. Zeits.* 37. *pp.* 854–855, *Dec.* 1, 1936.—The variation of charge transfer cross-section with velocity is measured for numerous kinds of ion in various gases for velocities below 30 V. In all cases an anomalous increase of cross-section with decrease of velocity is found to occur over part of the velocity range somewhat similar to the Ramsauer effect in the passage of electrons through gases. J. E. K.

**893. Electron Optics. H. Busch.** *Zeits. f. techn. Physik,* 17. 12. *pp.* 584–588, 1936.—A review is given of the fundamental nature, principles, methods and applications of electron optics and is followed by a brief account of the history of development of this branch of physics from its origin some ten years ago through the recent period of its intensive development up to the present day. J. E. K.

***894. Electron Optics and Applications. E. Brüche.** *Zeits. f. techn. Physik,* 17. 12. *pp.* 588–593, 1936.—This paper comprises a brief survey of the essential components and applications of electron-optical apparatus. It is divided into the following four sections: (1) Electron lenses, fundamental types of electric and magnetic lenses and their modifications. (2) Electron-optical apparatus, the application of electron optics to investigation of the crystal structure of foil, kathode-ray tube design and the electron microscope. (3) Electron-optical emission research, structure and emission of thermionic and photoelectric kathode, secondary emissive surfaces. (4) Development of applied electron optics. J. E. K.

**895. Problems of Electron Optics. O. Scherzer.** *Zeits. f. techn. Physik,* 17. 12. *pp.* 593–596, 1936.—The principal problems of theoretical electron optics are firstly the application of Gauss dioptrics to the calculation of the paths of paraxial electron beams, secondly the calculation of the aberrations of given electric and magnetic fields and thirdly the calculation of fields in which the aberrations are as small as possible. An indication is given of the mathematical difficulties of such calculations and of their possible utility in relation to the future refinement in design of electron optical systems. J. E. K.

**896. Electron Motion as an Optical Problem. W. Glaser.** *Zeits. f. techn. Physik,* 17. 12. *pp.* 617–622, 1936.—The motion of electrons in a magnetic field is formulated as an optical problem. The corresponding refractive index is given and leads to the development of Gauss dioptrics and the eight third order aberrations. J. E. K.

***897. Electron Mirror. A. Recknagel.** *Zeits. f. techn. Physik,* 17. 12. *pp.* 643–645, 1936.—In the case of an electron-optical single lens it is shown that in the potential region in which the transition of lens into mirror takes place, the refractive index, considered as a function of the lens potential, follows an oscillatory course, the successive lens images getting closer and closer together as the potential which prevents passage of electrons through the lens system is approached. The aberrations of the system are discussed and their influence on the image forming properties of lens and mirror are tested. J. E. K.

***898. Electron Mirror. G. Hottenroth.** *Zeits. f. Physik,* 103. 7–8. *pp.* 460–462, 1936.—A brief description is given of a method of obtaining electron images by reflection. Electrons emerging from a plane kathode pass through an " immersion lens " which acts as a condenser and, after traversing a wire network which serves as an object, are so deviated by a transverse magnetic field that they fall on the electron mirror and are reflected thence to a fluorescent screen. A magnetic lens is used to focus an image of the wire network on the mirror. The latter consists of 3 diaphragms, the 2 outer ones being at the anode potential (750 V) and the inner one being at a variable potential. A high negative potential on the inner diaphragm gives rise to reflection (a positive or moderately high negative potential gives rise to a converging effect on the electrons). A sharply focused image of the network is obtained on the fluorescent screen. H. J. H. S.

**899. Electron Optics of an Image Tube. G. A. Morton and E. G. Ramberg.** *Physics*, 7. *pp.* 451–459, *Dec.*, 1936.—The paper includes :—(1) Description of fixed-focus and variable-focus electrostatic image tube ; scope of paper. (2) Measurement of the variation of image distances and magnification with object distance and ratio of applied voltages for both types of tubes ; calculation of voltage distributions and electron paths ; comparison of experimental and theoretical results. (3) Classification of aberrations : measurement of tangential and sagittal image surfaces for fixed-focus tube ; calculation of axial (chromatic and spherical) aberrations ; calculation of field aberrations ; comparison between measurements and calculation ; reduction of field aberrations by curving the kathode. AUTHORS.

***900. New Electron Microscope. L. C. Martin, R. V. Whelpton and D. H. Parnum.** *Journ. Sci. Instruments*, 14. *pp.* 14–24, *Jan.*, 1937.—A new two-stage electron microscope has been designed and made for the express object of the microscopy of small objects by means of electron beams. The apparatus includes an optical microscope, means are provided to bring any required object detail from the optical to the electron system. The focusing coils are mounted in the vacuum, and the design allows of the centring of the various parts on the electron beam axis. AUTHORS.

**901. Electron Optics of Long Magnet Coils. H. Busch.** *Ann. d. Physik*, 28. 1. *pp.* 11–20, *Jan.*, 1937.—In a former paper [see Abstract 1099 (1927)] the author derived the equations of the path of an electron in a homogeneous magnetic field with radial symmetry. A method was also given for determining $e/m$ by measurements of the focal length of the magnet coil. A supplement to this paper is now given, in which correction terms may be applied to the formulæ previously derived for a coil which gives a field which is not homogeneous. H. J. H. S.

**902. Electron-Optical Observation of Metal Surfaces. Parts I and II. W. G. Burgers and J. J. A. P. van Amstel.** *Physica*, 4. *pp.* 5–22, *Jan*, 1937. *In English.*—After an introductory part regarding the construction of the kathode-ray tube, the phenomena are discussed, and illustrated by means of a number of photographs, taking place on activating Fe with Sr (starting from $SrCO_3$), so that an intensive emission pattern of its crystalline texture is obtained. It is suggested that the applied method of activation has some features in common with the activation of thoriated W. In Part II the changes occurring in the emission pattern of Fe on transition of the $\alpha$- into the $\gamma$-modification and vice-versa are illustrated by means of a number of photographs. The observed phenomena are discussed as well from a metallographical point of view as in connection with questions of electron emission. The occurrence of a zone of temporarily abnormal emission in front of a growing crystallite has been considered to be an indication that the transition process is accompanied by a migration of activating atoms in the growing zone. AUTHORS.

***903. Apparatus for Transformation of Light of Long Wave-Length into Light of Short Wave-Length. Amplification by Secondary Emission. F. Coeterier and M. C. Teves.** *Physica*, 4. *pp.* 33–40, *Jan.*, 1937. *In English.*—By the application of curved magnetic fields it is found possible to project an electron image from a photo-kathode, where it is produced from an optical image, on to a second surface inclined to the photo-kathode at an angle of up to 180° without any appreciable loss of definition. At the second surface the electron image may be amplified by secondary emission and the amplified electron image may be deflected by a further curved magnetic field and projected on to a third surface and so on. In this way secondary emission multiplication may be applied to the picture transformer described in a previous article [see Abstract 369 (1937)]. The curved magnetic field also permits the use of a non-transparent photo-kathode and a fluorescent screen deposited on a thick base layer in a picture transformer and eliminates back-reflection of light from screen to kathode. J. E. K.

***904. Polar Coordinate Kathode-Ray Oscillograph with a Linear Time-Base. M. v. Ardenne.** *Zeits. f. techn. Physik*, 17. 12. *pp.* 660–666, 1936. *Wireless Engineer*, 14. *pp.* 5–12, *Jan.*, 1937.—A kathode-ray oscillograph is described in which the trace on the fluorescent screen is circular. This is obtained by means of a "mixed" focusing system; the voltage of the oscillating circuit is applied to the deflection plates and to 2 magnet coils, placed at right angles to the plates and on either side of them. The time-base is almost linear and it is possible to compare phase differences. The period of the tracing beam lies between 1/600 and 1/200,000 sec., whilst the accuracy of measurement is of the order of 0·5 % of this period. By the addition of a cylindrical lens (electrostatic type), radial measurements may be made. Examples of the use of the instrument are given. H. J. H. S.

*See also* Abstracts 425, 433, 434, 494, 495, 511, 603, 631, 651, 752.

## ELECTROSTATICS.

**905. Very Accurate Test of Coulomb's Law of Force Between Charges. S. J. Plimpton and W. E. Lawton.** *Phys. Rev.* 50. *pp.* 1066–1071, *Dec.* 1, 1936.—The exponent 2 in Coulomb's universe square law of force between charges in empty space is shown experimentally to be correct to within 1 part in $10^9$. The electrostatic experiment of Cavendish and Maxwell with concentric metal globes is replaced by a quasi-static method avoiding difficulties due to spontaneous ionisation and contact potentials. A resonance electrometer (undamped galvanometer with amplifier) is placed within the globes to measure any variable p.d. between them. The electrometer, which is observed through a conducting window at the top, is shown theoretically to have no influence on the result, and to replace electrically a part of the inner globe. No effect is observed when a harmonically alternating high potential $> 3000$ V is applied to the outer globe. The experiment is sensitive to $10^{-6}$ V. If the exponent in the law of force were not exactly 2 but rather $2 \pm q$ then $q < 2 \times 10^{-9}$ in space remote from matter. N. M. B.

***906. Electrostatic Generator Operating Under High Air Pressure. R. G. Herb, D. B. Parkinson and D. W. Kerst.** *Phys. Rev.* 51. *pp.* 75–83, *Jan.* 15, 1937.—A belt-type electrostatic generator has been developed which operates in a steel tank, 5½ ft. in dia. and 20 ft. long, under an air pressure of 100 lb./in². The generator is provided with a h.v. voltage electrode system of a new design which serves both to give a high breakdown voltage and to furnish a satisfactory voltage distribution along the charging belts and the accelerating tube. The maximum voltage of the generator is about 2500 kV and the highest steady voltage at which reliable data have been obtained is 2160 kV. An evacuated tube for acceleration of ions has been developed which withstands the highest generator voltage. The apparatus has been successfully used in experiments on atomic disintegration. AUTHORS.

*See also* Abstracts 490, 757.

## GALVANOMAGNETIC AND THERMOMAGNETIC EFFECTS.

**907. Thermomagnetic Properties of Nickel. Part III. W. Band.** *Phys. Soc., Proc.* 49. *pp.* 14–16, *Jan.* 1, 1937.—The paper constitutes a brief report of results of a complete and careful analysis of observations previously published on the e.m.sf. found in nickel wires. [For Part II see Abstract 870 (1936).] AUTHOR.

## MAGNETISM AND ELECTROMAGNETISM.

**908. Permanent Magnetisation of Steel by Rapid Aperiodic Electric Discharge. R. Chevallier and M. Laporte.** *J. de Physique et le Radium*, 7. *pp.* 453–460, *Nov.*, 1936.—An aperiodic discharge was produced from a 46 m.f. condenser through a Ne tube. The quantity was 0·0576 coulomb and the duration of the discharge $28 \times 10^{-6}$ sec. The enclosed tube illuminated a slit, the image of which was reflected by a rotating concave mirror on to a photographic plate. The speed of the image on the plate was found from the pitch of a siren attached to the mirror. The current was led through a long straight conductor; its instantaneous value increased from zero to a maximum which was determined by a magnetic method. The mean current intensity was 2050 A. Short steel wires were placed tangential to the lines of the field near the long conductor. At the short distance from the latter the magnetisation of the needles was in the opposite direction to that expected; at a slightly greater distance the magnetisation was zero, and with increased distance normal magnetisation was obtained which reached a maximum and then fell away. It is pointed out that the inversion does not depend on a periodic discharge, that there is no transverse field, and that the part played by Foucault currents is negligible. The smaller the demagnetising factor of the specimens, the farther is the neutral point from the conductor. The "equivalent field" $H_e$ at the same distance *d* varies according to a complex law which depends on the nature of the steel and its previous treatment. It was exceptional to find a constant value for $H_e d$; the maximum value 500 found for this product corresponded to an equivalent current of 2500 A. G. E. A.

**909. Reversible and Irreversible Magnetisation Processes on Alteration in Temperature. N. Embirikos and H. Bittel.** *Phys. Zeits.* 37. *pp.* 901–906, *Dec.* 15, 1936.—The hysteresis loops of pure Ni, Ni + 1 % Mn, Ni + 1 % Cr and Ni + 2 % Cr become much narrower on shaking the specimen. The magnetisation changes which occur in a sample in a contant field by alteration in temperature are recorded and reversible and irreversible components of change are obtained; reversible part is obtained by avoiding shaking (on increasing the temperature, the intensity of magnetisation decreases steadily and vice-versa over the region 15 $\rightleftarrows$ 100° C.). The magnitude of the alteration varies with field strength but the % magnetisation change is the same for all fields. The observed reversible magnetisation change can be completely accounted for by the temperature variation of spontaneous magnetisation. Experiments on the electrical resistance of the specimens show that a resistance alteration occurs on switching the field on or off (large increase on switching on, small decrease on switching off) but no perceptible change occurs if the specimen is shaken. H. J. H. S.

**910. Temperature Variation of Intensity of Magnetisation of Ferromagnetics in Weak Fields. K. Honda and T. Nishina.** *Zeits. f. Physik*, **103**. 11–12. *pp*. 728–737, 1936.—Measurements of the intensity of magnetisation of single crystals of Fe, polycrystalline electrolytic Fe and Ni in fields up to 0·26 Oe (Fe) and 0·80 Oe (Ni) show that the intensity increases in 2 or 3 stages as the temperature is raised. An explanation of the origin of these stages is offered in terms of the Honda-Ôkubo theory of ferromagnetism; this theory is also capable of explaining the Hopkinson effect (gradual increase in intensity with increase in temperature, followed by a rapid rise and sudden fall at the $A_2$ point) which occurs in weak fields (but greater than those here used). H. J. H. S.

**911. Magnetic Time-Lag. H. Wittke.** *Ann. d. Physik*, **27**. 7. *pp*. 622–624, *Dec*., 1936.—The method developed in previous communications [see Abstract 4407 (1935)] for measuring the change with time of the induction after a sudden change of the magnetic field, is extended to longer times, of the order of 2 sec. It is now found that after such large time the approach of the induction as its asymptotic value does not follow an exponential law, but an inverse square law. R. P.

**912. Magnetic Skin-Effect in Ferromagnetic Cylinders. B. Kyewski.** *Ann. d. Physik*, **27**. 7. *pp*. 625–642, *Dec*., 1936.—A mathematical investigation of the behaviour of a cylindrical conductor in a longitudinal alternating magnetic field. Expressions are derived for the field distribution, total flux, Joulean heating and stored magnetic energy, assuming the Rayleigh-Jordan law for the hysteresis loop in weak fields and Arkadiew's theory of ferromagnetism in strong fields. The difference between the permeability values derived from the Joulean heating and from the self-inductance is also computed [see Abstract 4874 (1936)].
C. E. W.

**913. Magnetic Anisotropy of Single Crystals of Fe and Ni. H. Schlechtweg.** *Ann. d. Physik*, **27**. 7. *pp*. 573–596, *Dec*., 1936.—After a brief review of the fundamental principles, it is shown that 2 types of equation are of interest in solving magnetic problems in the region of intense fields, if the effects can be described in terms of the rotation of the magnetisation vector; in one group, by employing energy considerations, a relation may be found between the internal field and the magnetisation and in the other, by a consideration of the problem of demagnetisation, the spatial distribution of the internal and external fields in relation to the magnetisation may be deduced. It is shown that a single crystal disc hanging in a magnetic field with its plane parallel to the field experiences a torsional moment (J) which changes discontinuously at those places where it is in unstable equilibrium; certain simple cases, *e.g.*, when a cubic or dodecahedral plane lies in the plane of the disc, are discussed. A formula is given for calculating the magnetisation curve for any crystallographic plane, as well as one for calculating the torsional moment experienced by a disc in intense fields. The mechanism of rotation of the magnetisation vector first appears noticeable in fields for which $h = \mathrm{HJ}_{\infty}/\mathrm{K} > 4$. The anisotropy constant (K) for Krupp's transformer alloy is found to be $2 \cdot 6 \times 10^5$ erg./cm$^3$. which is considerably less than that of the Swedish Fe used by Honda and Kaya. H. J. H. S.

**914. Ferromagnetic Anisotropy of Iron Crystals at Various Temperatures. R. G. Piety.** *Phys. Rev.* 50. *pp.* 1173–1177, *Dec.* 15, 1936.—Magnetisation curves in important crystallographic directions in small oblate spheroids cut from H-purified iron crystals show ferromagnetic anisotropy of the same sort as that previously reported for iron of less purity. At room-temperature agreement with earlier work is good. At 296° C. and at 500° C. the principal (fourth-order) term in the anisotropy is larger, at 650° C. and 696° C. the same term is smaller than in earlier studies, anisotropy not being detected. The subsidiary (sixth-order) term is not accurately determined. The pendulum magnetometer method, which has certain advantages for such purposes over classical methods, was used and results for different spheroids agree well, especially at the higher temperatures. [See Abstract 387 (1937) and following Abstract.] AUTHOR.

**915. Ferromagnetic Anisotropy of Nickel-Iron Crystals at Various Temperatures. J. D. Kleis.** *Phys. Rev.* 50. *pp.* 1178–1181, *Dec.* 15, 1936.—Magnetisation curves in important crystallographic directions at temperatures up to near the Curie points in small oblate spheroids cut from annealed face-centred cubic Ni-Fe alloys with from 10 to 50 % Fe show a change in ferromagnetic anisotropy at about 24 % Fe. With less than this amount of Fe the order of increasing difficulty for magnetisation to saturation is, as in Ni at room-temperature: <111>, <110>, <100>. With more than this amount of Fe the order is <100>, <111>, <110>. A small decrease in the apparent demagnetising factor of the spheroids with rising temperature was noted. [See preceding and following Abstracts.] AUTHOR.

**916. Ferromagnetic Anisotropy in Nickel-Cobalt-Iron Crystals. L. W. McKeehan.** *Phys. Rev.* 51. *pp.* 136–139, *Jan.* 15, 1937.—Single crystals of ternary alloys of Ni, Co and Fe with 40 % Ni or more have been examined, with a pendulum magnetometer, for ferromagnetic anisotropy. All alloys in this region have face-centred cubic structures, like that of Ni. A region of low anisotropy, for nearly equal Co and Fe contents, appears to be connected with the points where binary alloys of Ni and Co on one side and of Ni and Fe on the other side change their anisotropy types. Measurements were made in all cases at room-temperature, at about 200° C., and at about 400° C. At the higher temperatures anisotropy of either type generally diminishes and, in the region of low anisotropy, the principal anisotropy constant may change sign. The previously reported data for the binary alloys and single components in this system are recomputed and presented so as better to show the boundaries of the ternary field. [See preceding Abstract.] AUTHOR.

**917. Magnetic Anisotropy of Naturally Occurring Substances. P. Nilakantan.** *Indian Acad. Sci., Proc.* 4*A. pp.* 542–550, *Nov.,* 1936.—The magnetic anisotropy of the shells of *Placuna placenta, Pinna bicolor, Meretrix casta, Vulsella rugosa, Mactra* sp., and *Turbinella perium,* are determined. In all cases, the crystalline character of the elements as well as their regularity of arrangement are established and the probable orientations deduced. In the case of *Placuna placenta* information regarding the character and *habit* of the crystalline elements is obtained. [For Part I see Abstract 1363 (1936).] AUTHOR.

**918. Conformable Invariant Form of the Relativistic Equations of Motion of Charged Particles. J. A. Schouten and J. Haantjes.** *K. Akad. Amsterdam. Proc.* 39. 9. *pp.* 1059–1065, 1936. *In German.*—Having previously shown [see Abstract 3911 (1934)] that the Maxwell equations and the impulse-energy equations can be written in a conformable-invariant way, it is pointed out in the present paper that the relativistic equations of motion of charged particles can be brought into a conformable-invariant form, supposing that the mass is so transformed that the product of mass into length remains invariant. Then $h/c$ (dim. [ML]) plays a similar rôle to $c$ in the usual relativity theory. Instead of the rest-mass $\overset{\bullet}{m}$ comes another invariant the conformable mass $\overset{*}{m} = \overset{\bullet}{m}(-g)\frac{1}{8}$ which has the dimension [ML]. The simple mathematical facts are given without physical speculations. J. J. S.

**919. Inductance of Iron-Cored Coils Carrying Direct Current. G. F. Partridge.** *Phil. Mag.* 23. *pp.* 99–106, *Jan.,* 1937.—The inductance of an iron-cored coil to alternating current is generally very much smaller when the alternating current is superposed on a direct current. This has been shown to be due to the fact that the permeability of the iron is considerably reduced by the presence of direct current. In order to obtain a larger inductance an air gap is introduced into the iron circuit. A method of calculating the required optimum air gap is worked out. [See also Abstract 5302 (1936).] AUTHOR.

**920. Temperature Dependence of the Magnetostriction of Nickel. W. Döring.** *Zeits. f. Physik,* 103. 9–10. *pp.* 560–582, 1936.—Measurements were carried out of the longitudinal magnetostriction of polycrystalline Ni at various temperatures. Special emphasis is laid on the comparison between saturation magnetisation and saturation magnetostriction, upon the disappearance of the magnetostriction at the Curie point, and upon the magnetostriction effect in the region of the magnetic saturation. The saturation magnetostriction was found to be within the errors of measurement proportional to the square of the saturation magnetisation. J. J. S.

***921. Magnetisation Model. F. W. Warburton.** *Am. Phys. Teacher,* 4. *pp.* 213–214, *Dec.,* 1936.—The model consists of an open solenoid coil within which 15 small coils are suspended, and a secondary coil for measurement of flux densities. The small coils, which represent atoms of iron, are visible and show self-magnetisation, alignment in the applied field, and hysteresis. The model illustrates an advantage of defining *B* and *H* in the same manner. AUTHOR.

***922. Construction of Electromagnets. A. Cotton.** *R.G.E.* 41. *pp.* 3–9, *Jan.* 2, 1937.—The author replies to criticisms raised by L. Dreyfus concerning the large electromagnet of the Académie des Sciences at Bellevue compared with that of the University of Upsala. The Upsala magnet (37 tons) was built to produce intense fields in relatively small gaps, whereas the Bellevue magnet (110 tons) can be fitted with pole-pieces up to 75 cm. in dia. The author refers to the necessity for extensive fields in certain researches, and states that Dreyfus ought not to have compared the two instruments by taking arbitrarily the same number of ampere-turns in both cases. He deals with Dreyfus' criticism of the core design of the Bellevue magnet and shows that these cores are not subject to the alleged saturation limits. On the rational basis of comparison, that of equal power expenditure, the inductions obtained in equal gaps are nearly the same, the difference being due to the fact that the absence of large polar pieces enables the coils of the Upsala magnet to be brought closer together, thus giving higher direct fields. R. E. N.

*See also* Abstracts 480, 481, 528, 610, 752, 756, 792, 854.

## MEDICAL RADIOLOGY AND ELECTROLOGY.

***923. Million-Volt X-Ray Tube.** *El. Times*, 90 *pp.* 811–813, *Dec* 17, 1936.—A description of the highest-voltage therapy plant yet installed. This is a Metropolitan-Vickers million-volt tube of the continuously-evacuated type and is now in use at St. Bartholomew's Hospital in London, primarily for cancer treatment. The tube is operated by two d.c. generators each supplying up to 600 kV, the mid-point being at earth potential. The tube itself is in the treatment room but its ends are continued through the walls to the two generator rooms. The positive generator is connected to the tube anode and the negative to the kathode, which comprises a hexagonal head carrying six filaments for easy replacement. The anode is of copper, water-cooled, and carries a gold target. The filament current is supplied by a d.c. generator driven by an insulated shaft, as it operates at −600 kV. The e.h.v. circuit is a 2-stage Cockcroft multiplier comprising thermionic rectifiers and condensers. Radiation through the walls is prevented by the use of barium bricks. E. H. W. B.

**924. Thermal Response of the Skin to Radiation. J. D. Hardy and T. W. Oppel.** *Physics*, 7. *pp.* 466–479, *Dec.*, 1936.—The thermal sensitivity of skin to radiation is studied with a new technique and the temperature changes in the skin surface are accurately measured. The change in skin response of both whites and negroes to visible, infra-red radiation, and sunlight is measured. Results show that the sensation evoked by the radiations depends upon the optical properties of the skin. White subjects are found to be more sensitive to heat than negroes. The effect of the exposed area upon the sensitivity is observed. The postulate that the magnitude of the sensation depends upon two factors, nerve impulse frequency and central association, is found to fit the present data. A formula for calculating the degree of association is proposed. The results show that the sensitivity to radiation increases as the exposed area is increased up to the point where the stimulus has dropped to 0·0004 cal./sec.·cm$^2$. A radiation weaker than this will evoke no sensation regardless of the size of the area exposed. This is taken to be the threshold of the excitation of an end organ. The temperature change in the skin surface with this radiation rate is measured to be a rise in temperature at the rate of 0·0008° C. per sec.; sensation is perceived after 3 sec. of exposure. The relationship of the temperature change of the skin is studied. It is found that neither the change ($\Delta T$) nor rate of change ($\Delta T/\Delta t$) of skin temperature is adequate to explain the sensory effect. A hypothesis is proposed which attributes the sensation to a differential change in the temperature of the blood vessel net work within 0·1 mm. of the skin surface and another at 0·3 mm. AUTHORS.

## OSCILLATIONS AND WAVES.

**925. Theory of Motion of Electrons in Crossed Electric and Magnetic Fields with Space Charge. S. V. Bellustin.** *Phys. Zeits. d. Sowjetunion*, 10. 2. *pp.* 251–256, 1936. *In English.*—The solution of this problem for a plane condenser given by Braude [see Abstract 4412 (1935)] was criticised by Tonks [see Abstract 1376 (1936)]. It is here shown that the conclusions reached by Braude in examining the case of plane electrodes result from an assumption implied in his initial equations and can be claimed to have physical meaning only on so far as the equations in question remain valid. The revision of Braude's investigation removes the objections raised by Tonks and makes the conclusions reached by Braude acceptable, both mathematically and physically. The arguments applied to the case of plane electrodes apply to a certain extent to the case of cylindrical electrodes [see Abstract 1886 (1936)]. Braude's representation of the return path of an electron is, however, incorrect. The shape of the return path should be symmetrical with respect to the direct motion branch. Note by **S. J. Braude,** *ibid.* 10. 3. *pp.* 429–430, 1936. A. W.

**926. Fundamental Types of Electron Oscillations in a Triode. R. Cockburn.** *Phys. Soc., Proc.* 49. *pp.* 38–58; *Disc.*, 58–60, *Jan.* 1, 1937.—Experiments with a retarding-field triode confirm that electron oscillations can be maintained whose wave-lengths are determined completely by the external circuit (Gill-Morell oscillations) and that, in addition, oscillations can be obtained with wave-lengths completely independent of the external circuit, provided the latter does not approach resonance with them (Barkhausen-Kurz oscillations). Examination of the B-K oscillations shows that for any given set of conditions there are two possible fundamental wave-lengths, type A, of shorter wave-length, and type B, of longer wave-length, both of which may give harmonics. Application of theory developed in a previous paper [see Abstract 4018 (1935)] leads to the conclusion that the A-type oscillations are due to the periodic transit of electrons between the kathode and the virtual anode, while the B-type are determined by the resonant circuit formed by the grid-anode capacity in parallel with the equivalent inductance of the electron cloud between these electrodes. In the *Discussion*, the existence of two different mechanisms for the two types of oscillation is questioned and other possible explanations are advanced. A. W.

***927. Variometer for an Oscillator of Wide Frequency Range. J. A. Pierce.** *Rev. Sci. Instruments*, 8. *pp.* 24–27, *Jan.*, 1937.—A variometer is described, of such construction that it may be used as the tank inductance in a Hartley oscillator, maintaining a constant excitation ratio over a wide frequency range. When the circuit is arranged to keep the inductance-capacitance ratio constant also, the efficiency and power output are correspondingly uniform. Although the problem, in the case illustrated, is complicated by the design of the oscillator for high plate voltages, the basic design is equally applicable to oscillators of lower power and much wider frequency range. AUTHOR.

**928. Influence of Magnetic Field on H.F. Characteristics of Ionised Gases. Y. Asami and M. Saito.** *I.E.E., Japan, J.* 56. *pp.* 882–884, *Aug.*, 1936. *English Abstract.*—A study was made of the h.f. conductivity and the dielectric constant of ionised gases under the influence of a constant magnetic field. Discharge tubes with hot kathodes and at low pressures of the order of $10^{-3}$ to $10^{-4}$ mm. were used. Curves are given showing the h.f. characteristics of argon and air for various wave-lengths between 2 and 10 m. and for field-intensities up to about 50 gauss. The relation between the h.f. loss and the capacity variation of the ionisation condenser is, under suitable conditions, very similar to that between the absorption coefficient and the index of refraction in the case of anomalous dispersion, so that it appears probable that most of the h.f. characteristics obtained represent properties of the ionised gases themselves and are not due merely to secondary phenomena. A. W.

**929. Ionospheric Investigations During the Solar Eclipse of June 19th, 1936. I. Ranzi.** *N. Cimento,* 13. *pp.* 297–303, *July,* 1936.—Up to the present researches made into the condition of the ionosphere have led to the conclusion that for the greater part the ionisation is due to solar radiations ; various facts show the arrival also of corpuscular ionising radiations. The observations in the $F_2$-region carried out at Bologna during the solar eclipse of the 19th June, 1936, have led to the following conclusions : (1) an anticipation in the beginning of the ionospheric eclipse with respect to the optical of about 40 min. ; (2) two minima of electronic density, the one in anticipation of 30 min., the other in retardation of 20 min. with respect to the maximum of the eclipse ; (3) a minimum value of the electronic density during the eclipse considerably inferior to the nocturnal minimum. The author discusses the possible interpretation of such phenomena. J. J. S.

**930. Influence of the Partial Solar Eclipse of 19th June, 1936, on the Ionosphere. H. Aschenbrenner, G. Goubau, J. Petersen and J. Zenneck.** *Hochfrequenztechn. u. Elektroakustik,* 48. *pp.* 181–182, *Dec.*, 1936.—Observations with echo-recording apparatus carried out prior to, during and after the partial solar eclipse of 19th June, 1936, show that about 15 min. after the time at which the eclipse would be a maximum at a height of 200 m. a marked decrease of electron concentration occurs, though whether this is directly attributable to the eclipse is somewhat uncertain, as the beginning of the eclipse approximately coincided with the time of sunset. A. W.

***931. Simplified Automatic Recorder for Ionospheric Height Measurement. R. C. Colwell, N. I. Hall and L. R. Hill.** *Science,* 84. *pp.* 515–516, *Dec.* 4, 1936.—The recording system has one inherent error, believed to be common to all others. Weaker echoes traverse the receiver more slowly ; the longer time-lag is read as an increased layer height. The time-lag is measured by impressing the r.f. transmitted pulse directly on the oscilloscope deflector plates. The lag found (on a National Fb-7 receiver) is about 5 km. for a strong pulse and about 20 km. for a weak one. Calibrating the receiver for lag against signal strength permits a correction to be applied to the recorded data. Rapid changes of layer height (up to 10 km. in 1 min.), often recorded, are attributed to this cause. R. M.

**932. Sudden Anomalies in the Ionosphere. R. Bureau and J. Maire.** *Comptes Rendus,* 203. *pp.* 1275–1278, *Dec.* 7, 1936.—A correlation is established between fading on short waves and ionosphere disturbances revealed by atmospherics on long waves. The fadings referred to commence very suddenly, in a few sec. reducing to silence all receivers on trans-continental links, 15 to 45 m. The signals reappear a few min. later and gradually regain normal intensity. The duration varies from 10 min. to an hour. The atmospherics are observed on 7500 to 11,000 m. but rarely on 25,000 m. They also show very sudden increase, followed by progressive return to normal, lasting from 30 to 80 min. Atmospherics from all directions are simultaneously reinforced. It is concluded that both phenomena must be caused by the same modification in the ionosphere, affecting vast areas, and consisting probably of ionisation by u.v. rays. Indications of such disturbances should be sought also in geophysical and astrophyiscal events. [See following Abstract.] R. M.

**933. Probable Causes of Short-Wave Fading, and its Relation to Magnetic Phenomena. R. Jouaust, R. Bureau and L. Eblé.** *Comptes Rendus*, 203. *pp.* 1534–1536, *Dec.* 28, 1936.—In many cases of sudden fading [see preceding Abstract] determination of the critical frequency of various layers, shortly after the fading, has indicated an intense ionisation of the E-layer. Contrariwise, the F-layer ionisation was sometimes above and sometimes below normal. These considerations suggest that, during a very short time, the sun emits an agent, propagated rectilinearly, which produces intense ionisation of the lower layers. In these regions the pressure is higher; the more numerous collisions between electrons and molecules, and the higher frequency, both cause increased damping, such that complete stoppage of short-wave transmissions may be expected. The short duration of certain of the fadings requires postulation of more rapid recombination than do the nocturnal variations of the E-layer, so that probably regions of the ionosphere at a lower level are concerned. It cannot be said that there is any connection between the fadings and magnetic storms or anomalies in the horizontal component. R. M.

**934. Radio Expedition to Tromsö. K. Fränz.** *Zeits. f. Physik*, 103. 11–12. *pp.* 671–708, 1936.—A description is given of the apparatus used for direction-finding observations, field-strength measurements and for determining ionospheric heights by the echo method. Errors in direction-finding in the mean wave-length band were found to occur much more frequently than in the long-wave band. The mean direction at the time when errors occur was found to agree with the direction of incidence at times free from error. The direction-finding errors are attributed to polarisation of the waves. When no errors were observed at Tromsö, the polarisation was, within the accuracy of measurement, linear or at the most, weakly elliptic. The direction-finding errors exhibit a pronounced daily and yearly variation. In general, the times of strong northern lights and magnetic disturbances were free from direction-finding errors. The heights of the E- and F-regions at Tromsö were found to be normal but the normal ionisation in the E- and F-regions was found to be less than at other places. The abnormal ionisation occurring in the E-region coincident with northern light displays and magnetic disturbances is appreciably higher than at other places. A. W.

**935. Diffractive Propagation of Radio Waves. Part II. Elevated Transmitter and Receiver. B. Wwedensky.** *Techn. Phys., U.S.S.R.* 3. 11. *pp.* 915–925, 1936. *In English.*—A formula is found for diffractive propagation applicable (when conductivity of the earth is considered) to senders and receivers situated above ground level. Comparison with experimental results shows satisfactory agreement. The limits within which the new formula may be applied are given. A curve is adduced which considerably simplifies calculations with the preceding formula, for sender and receiver situated at ground level. The same curve also simplifies calculations made with the new formula. [See also Abstract 1894 (1936).] AUTHOR.

**936. Physical State of the Upper Atmosphere. B. Haurwitz.** *Roy. Astron. Soc. Canada, J.* 30. *pp.* 315–330, *Oct.*; 349–366, *Nov.*, and *pp.* 397–415, *Dec.*, 1936.—After referring to the two main divisions, troposphere and stratosphere, of the atmosphere the author discusses some optical phenomena such as mother of pearl clouds and noctilucent clouds, their positions and probable causes. Meteors and the information they supply about the upper atmosphere are considered, as also the light of the night sky, the spectrum of which is discussed. The last three sections are devoted to a study of the electric and magnetic properties of the upper atmosphere including the problem of its various ionised layers together with the propagation of electric waves; the diurnal variations of terrestrial magnetism attributable to electric currents in the atmosphere; and, finally, the aurora, the various hypotheses as to its origin being set out. The paper is illustrated by diagrams and photographic reproductions. A. E. M. G.

**937. Connection Between Atmospherics and Ionospheric Layers and Its Significance in Meteorology. G. Leithäuser and W. Menzel.** *V.D.E. Fachberichte, pp.* 179–181; *Disc.*, 181–182, 1936.—From numerous records obtained during a period extending from winter to summer it is concluded that definite relations exist between the height of the F-layer and the number and intensity of atmospherics. To each variation of the height of the layer of any great extent corresponds a variation of the number of atmospherics or of the quantity of electricity associated with them. Increases occur with regular unbroken layers before a marked increase of height or during the process of splitting up. Reductions are observed during the period when the height of regular unbroken layers is increasing and also when these are breaking up or suddenly falling. Of particular regularity is a maximum value which is observed shortly before the first increase of height of the layer at evening, as well as a maximum, especially in winter time, corresponding to the morning rise of the F-layer. Such an increase has also been observed during sinking of the layer and at other times during the night. The observed changes of amplitude of disturbances are the greater the greater the size of the origin of the disturbance. When in summer the number of atmospherics is approximately proportional to the temperature, the observed variations due to height changes of the layer are particularly large. In winter they are much smaller. Two other phenomena also have an appreciable effect, the existence of clouds with snow and electric charges. Sometimes the barometric pressure gradient over a large area round the observation station has an appreciable effect. In this connection it is found that amplitude variations are usually associated with pronounced low-pressure areas and also with the change from bright weather to rain. Particular examples are given showing the relations between atmospherics and the weather conditions. A. W.

**938. Nature of Atmospherics. E. V. Appleton and F. W. Chapman.** *Roy. Soc., Proc.* 158*A. pp.* 1–22, *Jan.* 1, 1937.—A series of observations on rapid changes of the earth's electric field associated with lightning flashes was made, using a Wilson sphere as the exposed conductor and a kathode-ray oscillograph with photographic registration. From observations on near discharges it was found that the discharge of a thundercloud is, in the main, aperiodic, but that during the period of maximum current density subsidiary oscillations or pulsations are superimposed on the main discharge. From observations made at increasing distances from the discharge the evolution of the atmospheric wave-form was studied. At a distance of 40–60 km. the radiation field of the atmospheric is approximately equal to the electrostatic field change of the main discharge. The most frequently observed wave-form of the atmospheric ultimately developed is a brief steep-fronted train of about 6 to 10 half-cycles of quasi-period 0·1 to 0·15 m.sec. Many of these trains are followed by a slower disturbance of exactly the same type as those described by Appleton, Watt and Herd. The quasi-oscillatory disturbance is found to move ahead of the slower disturbance during propagation, indicating a difference of group-velocities brought about by ionospherical influences. A. W.

***939. Double-Bulb Neon Oscillograph. J. F. Koehler.** *Am. Phys. Teacher,* 4. *pp.* 202–203, *Dec.,* 1936.—A simple apparatus is described for rotating two neon bulbs on the usual laboratory rotator. The juxtaposition of the two a.c. sine waves shown by the bulbs, simplifies the classroom demonstration of phase relations. AUTHOR.

*See also* Abstract 853.

## PHOTOELECTRICITY.

**940. Complex Photo-Kathode Mechanism. P. Lukirsky.** *Techn. Phys. U.S.S.R.* 3. 8. *pp.* 685–689, 1936. *In English.*—A comparative study is made of the different methods for the determination of the work function of the kathode. It is shown that in the case of complex kathodes the determination of the work function by the red limit of the photo-effect always leads to exaggerated values. The values of the work function, obtained by the most reliable methods, and the intensity of the thermionic emission are juxtaposed and an attempt is made to explain the absence of the emission phenomena at room-temperatures. The spectral characteristics of various kathodes are studied. In the case of pure metals and of metals covered with monomolecular layers, the spectral characteristics are brought into conformity with the optical constants of the metal. De Boer's theory of the nature of the photo-current for this case is criticised. The spectral characteristics of a cæsium photo-kathode are considered. An attempt is made to explain all the peculiarities of this kathode, based on a study of the influence of a number of factors on the kathode spectral characteristics. AUTHOR.

**941. Absolute Photoelectric Yields of Mg, Be and Na. M. M. Mann, Jr., and L. A. DuBridge.** *Phys. Rev.* 51. *pp.* 120–124, *Jan.* 15, 1937.—Measurements of the absolute photoelectric yields for distilled surfaces of Mg, Be and Na were made and values of $\alpha$ in Fowler's photoelectric equation determined. For Mg, Be and Na the values of the work function are, respectively, 3·68, 3·92 and 2·29 volts and of $\alpha$, 3·2, 25 and 180 × $10^{-34}$ cm$^2$. sec./quant. These values of $\alpha$ range from $10^{-2}$

to $10^{-3}$ of the maximum theoretical values. The ratios are interpreted as the fraction of light absorbed by the electrons in the surface potential barrier. AUTHORS.

*__942. Photo-Cells with Transparent Kathodes. P. Görlich and H. Sauer.__ *Zeits. f. Instrumentenk.* 56. *pp.* 423–425, *Oct.*, 1936.—Investigation of the Cs-$Cs_2O$-Ag kathodes of photo-cells has led to the adoption of transparent kathodes in which the emission centres are not confined to the outer surfaces, and Sb and Bi are used instead of Ag. Curves show the spectral distribution obtained in comparison with other types. These photo-cells are shown to have possible applications for measuring purposes, for moving pictures, optical telescopic appliances and for electronic multiplication. R. S. R.

*__943. Effect of Hydrogen on the Time-Lag of Argon-Filled Photoelectric Cells. N. R. Campbell and R. S. Rivlin.__ *Phys. Soc., Proc.* 49. *pp.* 12–13, *Jan.* 1, 1937.—In a previous paper of this series [see Abstract 4413 (1936)] it was stated that the addition of small quantities of $H_2$ to the A filling of a photoelectric cell with unsensitised K kathode reduced the time-lag greatly. The amount of $H_2$ necessary for this effect has now been determined roughly. A Pirani gauge has been found very suitable for determining a small proportion of $H_2$ in A. AUTHORS.

**944. Photoelectric Effects in Cuprous Oxide. W. Behrendt.** *Phys. Zeits.* 37. *pp.* 886–901, *Dec.* 15, 1936.—The *Vorderwand* effect is investigated at different wave-lengths for $Cu_2O$ cells provided with a front layer of sputtered gold. The photo-current and e.m.f. are found to increase up to a saturation value as the thickness of the front layer is increased. No *Vorderwand* effect is observed with a metal gauze. The results indicate the probability of electron absorption in the metal. Experiments are also carried out upon cells without blocking layers and it is found that for cells less than 1 mm. thick the photo-current for small external resistance is independent of the presence of such layers. Thermoelectric measurements show that there is no analogy between photoelectric and thermoelectric e.m.f. in $Cu_2O$ cells. The Schottky theory of the photoelectric effect in semiconductors is considered to be in better accord with observed facts than the theory of concentration elements. The Schottky theory is modified, the directional conductivity of the blocking layer being replaced by a consideration of the long diffusion paths of the electrons in the semiconductor and their absorption in the metal. Formulæ in qualitative agreement with observation are derived for the *Vorderwand*, *Hinterwand* and crystal photoelectric effects. Conclusions as to the dependence of the effects upon temperature are drawn from these formulæ and confirmed experimentally. L. A. W.

**945. Cooling of a Surface by Photoelectric Emission. H. M. Zenor.** *Phys. Rev.* 50. *pp.* 1050–1053, *Dec.* 1, 1936.—The cooling of a surface when photoelectrons are allowed to flow from the surface was measured. The surface consisted of a thin layer of Cs deposited on Pt, and the change in temperature was measured with a Fe-Ni thermocouple. The energy loss by the surface was found to agree approximately with that to be expected theoretically assuming that the photoelectrons lose very little energy in escaping by collisions or otherwise. AUTHOR.

*See also* Abstracts **454, 469, 587.**

## PIEZOELECTRICITY.

**946. Pyroelectric Behaviour of Picric Acid Crystals. G. Greenwood.** *Zeits. f. Krist.* 96. 1. *pp.* 81–84, 1937. *In English.*—In view of the fact that piezoelectricity has not been detected in picric acid crystals—a substance long ago described as being pyroelectric—it was decided to re-investigate the pyroelectric behaviour of this material. Large size crystals were obtained by a somewhat tedious method of crystallisation. These crystals were found morphologically to be holohedral. Attempts were made to detect a pyroelectric separation of charge on changing the temperature of the crystals. The methods used were direct electrometric methods, Kundt's dusting method and observation of effects at low temperatures. Negative results were obtained. The position is thus analogous to that of its piezoelectric behaviour: the effects may exist but to an undetectably small extent. AUTHOR.

*See also* Abstract 464.

## THERMIONICS.

**947. Colloid Science and Radio-Technique. A. v. Buzágh.** *Kolloid Zeits.* 77. *pp.* 172–182; *Disc.*, 182–183, *Nov.*, 1936.—Since thermionic kathodes are very important in radio-technique and it is necessary to be able to produce efficient ones with accuracy, methods of preparing oxide kathodes are discussed. It is shown that the active centres in the kathodes are of colloidal dimensions, 20–30 mμ, and not only the materials of which the kathodes are made but also the methods of making them influence their characteristics. Colloid methods are used for obtaining oxide kathodes of the alkaline earths. The carbonate of an alkaline earth is deposited from its aqueous solution by electrophoresis and is subsequently changed to the oxide by heat. The concentration of the solution, the p.d. between the electrodes and so forth, are of importance in obtaining a smooth, uniform layer which adheres well and is quickly formed. The method of Patai and Tomaschek [see Abstract 2918 (1936)] using a glycerin or glycol solution gives nuclei of known size and is good for quantitative measurements. The best dispersion was thought to be obtained with nuclei about the limiting size of colloidal particles, but newer methods show that particles of the mean size give the largest currents. Colloid methods are also valuable for making graphitic anodes and other colloidal layers. H. M. B.

**948. Negative Emission from Glowing Platinum in Chlorine. S. Kalandyk.** *Zeits. f. Physik*, 103. 9–10. *pp.* 583–597, 1936.—The abnormally high negative emission from glowing Pt in $Cl_2$ was studied at temperatures of the Pt from 900 to 1400° C. and for $Cl_2$ pressures of 0·01 and 1·5 mm. Hg. At the lower pressures the emission was independent of the pressure, and for temperatures below about 1180° C. conformed approximately to Richardson's formula with about the same value of the exit work as for Pt *in vacuo* but with 100 times greater value of the constant A. At higher temperatures the emission decreased until the value appropriate to Pt *in vacuo* was reached at about 1285 °C. Beyond this temperature the emission increased again according to Richardson's formula. At a $Cl_2$ pressure of 1·5 mm. the temperature variation of the emission was of a different type corresponding to a reduced exit work (about 1 V) at temperatures below 925° C. Above this temperature the exit work equalled 5·3 V (Pt *in vacuo*, 6 V). The results are discussed in connection with Noareda's work on the kinetics of the reaction between Pt and $Cl_2$. W. S. S.

**949. Thermionic Emission of Platinum. L. V. Whitney.** *Phys. Rev.* 50. *pp.* 1154–1157, *Dec.* 15, 1936.—The thermionic emission from round filaments and flat strips of Pt is measured giving a value for the work function of 5·32 V and 32 $A/cm^2 . deg^2$ for the constant A. Highest possible vacuum conditions and heat treatment near 2000° K. are found necessary for obtaining reliable results. The lack of such extreme heat treatment probably accounts for the abnormally high values of the constant A formerly found. Special theoretical explanations for Pt appear no longer necessary. AUTHOR.

**950. Modification of Apparent Thermionic Constants of Oxygenated Tungsten by the Temperature Variation of Adsorptive Equilibrium. M. C. Johnson and F. A. Vick.** *Roy. Soc., Proc.* 158*A*. *pp.* 55–68, *Jan.* 1, 1937.—Emission-temperature curves between 1300 and 2500° K. for W were taken in the presence of a low, but controlled pressure of $O_2$. The pressure was kept constant by means of traps which could be brought to different temperatures. For each pressure the Richardson graph is then curved and, if the thermionic constants are determined in a small temperature range, values are obtained which have no physical meaning. These "apparent" thermionic constants are plotted and it is shown that the apparent value of log A depends, at constant pressure, very nearly linearly on the work function. Similar conditions are to be expected in all cases in which, with increasing temperature, the chemical structure of the surface undergoes a reversible change. R. P.

**951. Processes of Liberation of Electrons from Glowing Solid Bodies. A. Gehrts.** *Zeits. f. techn. Physik*, 17. 12. *pp.* 656–660, 1936—Electron-optical investigations of thoriated kathodes permit considerations on the process of electron liberation from glowing solid substances. They confirm the view of Lenard, according to which the glow-electric electrons are not originally free, but first, before their escape from the surface, are electrons set at liberty from the atoms. The "neighbourhood action" of the atoms arising from heat-motion at the surface of the bodies is to be looked upon as the cause of the electron liberation from glowing solid bodies. J. J. S.

*See also* Abstracts 888, 889, 940.

## THERMOELECTRICITY.

*See* Abstract 944.

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